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HONOLULU LA JOLLA MONTEREY TIBURON

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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

Antarctic Research Planning Workshop Completed

The U.S. Antarctic Marine Living Resource (AMLR) Program is a national program providing information needed for U.S. policy relating to the conservation and management of marine living resources in the ocean areas surrounding Antarctica. The program is in support of U.S. participation in the Commission and Scientific Committee of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), which established a system for managing the living resources of the Antarctic ecosystem through international cooperation. During 1988 the AMLR Program was transferred to the Southwest Fisheries Center (SWFC) where it is administered by the Antarctic Ecosystem Research Group (AERG).

The Center is presently conducting an extensive review of CCAMLR goals to better determine research direction of the AERG. To complete this review, three separate panels have been established. An in-house task force comprised of Doug DeMaster, Roger Hewitt, Rennie Holt, Jeff Polovina, and Paul Smith reviewed AMLR and CCAMLR research conducted during the last few years and produced a background paper for members of a workshop panel. During the week of April 18 the workshop panel, comprised of world-class experts, met at the Center to provide advice in designing the AERG research program. The workshop panel included the CCAMLR Scientific Committee Chairman, the conveners of the CCAMLR working groups on fish and krill, several experts from academia, and NOAA Fisheries experts. The workshop meeting was facilitated by Aleco Christakis of the American Institute for Interactive Management. Members of the third panel attended the workshop as observers and will serve as advisors to the Center concerning U.S. policy, interactions with other agencies, and liaison with

Attendees at the Antarctic Planning Workshop (left to right): Don Siniff, University of Minnesota; John Kapelouzos, American Institute for Interactive Management (AIIM); Pierre Kleiber, SWF.; John Bengtson, National Marine Mammal Laboratory; Margi Fiore, AIIM; Rennie Holt, SWFC; Traci LaBerge, AIIM; Alexander Christakis, AIIM; Jeff Polovina, SWFC; Polly Penhale, National Science Foundation; Michael Tillman, NOAA Fisheries, Washington, D.C.; Raymond Hilborn, University of Washington; Inigo Everson, British Antarctic Survey; Paul Smith, SWFC; Izadore Barrett, SWFC; Roger Hewitt, SWFC; Tim Smith, NEFC, Woods Hole Laboratory; John Gulland, University of London; Denzil Miller, Sea Fisheries Research Institute, South Africa; David Mackett, SWFC; and Karl- Hermann Koch, Institut Fur See Fischerei, West Germany. Not pictured, Robert Hofman, Marine Mammal Commission; Bruce Manheim, Environmental Defense Fund; and Tucker Scully, U.S. Department of State.

Fisheries Headquarters. The advisory panel members were Robert Hofman (Marine Mammal Commission), Bruce Manheim (Environmental Defense Fund), Polly Penhale (National Science Foundation), Tucker Skully (State Department), and Mike Tillman (NOAA Fisheries Headquarters).

The workshop panel identified 76 research tasks which should be considered in developing our research plan. They grouped these into 12 categories which were paradigms, assessment, ecosystem interactions, stock structure, feeding, spatial pattern, surveys, fishery, history, experimental management, field methodology, and worry (concerns). The task force then reviewed these tasks and identified 27 additional tasks which were placed into the above 12 categories plus a communications category.

The task force will use these 103 tasks to develop several options for the AMLR research strategy. These options will be reviewed by the advisory panel, which will make recommendations to the Center. A final research plan will be developed, which will be used to design the AMLR 1989-90 field season. (R. Holt, FTS 893-7098)

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

COASTAL EASTERN PACIFIC FISHERIES ENVIRONMENTAL INVESTIGATIONS

California Current Eddy Dipole System Analyzed

Physical Oceanographer Ronald Lynn and coauthor Dr. James Simpson of Scripps Institution of Oceanography have completed final editing on two manuscripts dealing with the oceanography of the California Current System off southern California. The papers are to be published in the Journal of Geophysical Research. The manuscript, with Lynn as senior author, "The influence of bathymetry upon the flow of the undercurrent off southern California," was described in the September-October 1988 Report of Activities. The other manuscript, with Simpson as senior author, "A mesoscale eddy dipole on the offshore California Current," reports on satellite and shipboard observations taken aboard the David Starr Jordan in July 1985.

This most recent report describes the discovery in 1985 of two opposing eddies or gyres about 250 miles (400 km) southwest of Point Conception. These eddies extended deep into the water column, entraining the California Undercurrent waters at depth and the California Current waters near the surface. There is evidence that the pair of eddies, called an eddy dipole, influenced offshore biological productivity and general circulation patterns off of the Southern California Bight during the time of observation in July 1985.

There is a transition zone in the California Current System between inshore coastal and offshore oceanic flow. This transition zone is associated with the main core of the California Current and is populated with offshore mesoscale eddies. The observation of a mesoscale eddy dipole, 400 km southwest of Point Conception, in satellite imagery was confirmed by the shipboard data (Figures 1 and 2). Water mass analysis showed that the anticyclonic member

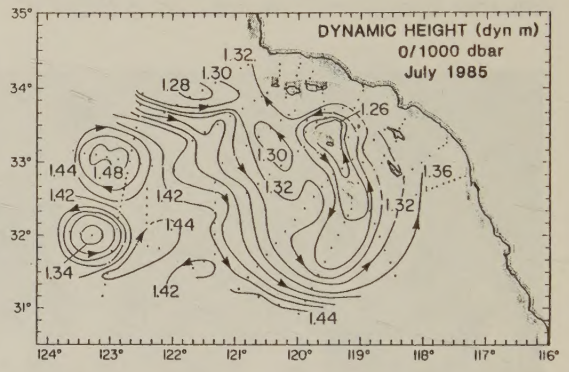


Figure 1. Dynamic height of the sea surface reveals the eddy dipole system in the pattern of surface flow.

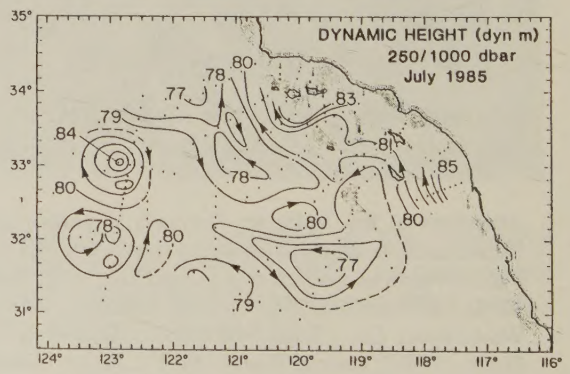


Figure 2. Dynamic height at 250 m reveals the California Undercurrent, the dipole system and a complex pattern connecting the dipole to the undercurrent.

contained waters of California Undercurrent origin (Figure 3). The dipole was not an isolated system. Both the satellite and in situ data show that near-surface waters from the California Current were laterally entrained into the frontal structure surrounding the dipole. Near-surface lateral entrainment by eddies and/or secondary vertical circulation produced by eddy - mean flow interaction may partially explain the offshore secondary maximum in biological productivity observed in the California Current. The authors conclude that the dipole was likely caused by a bathymetrically-induced baroclinic instability of the California Undercurrent near the Santa Rosa-Cortes Ridge during a period of seasonal increase in current strength.

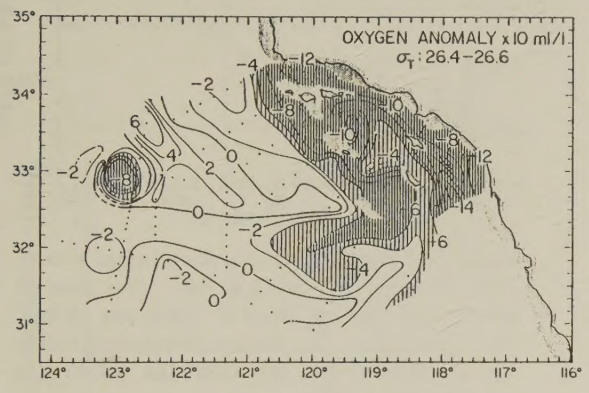


Figure 3. The distribution of oxygen deficit in a density range found near 200 m corresponds closely to the 250 m circulation pattern and shows water characteristics typical of the coastal undercurrent in the dipole.

In the companion manuscript by Lynn and Simpson, analysis of the long term CalCOFI data implies that the instability of the undercurrent and subsequent eddy formation are typical of this location at this time of year. (R. Lynn, FTS 893-7084)

SURVEY SYSTEMS DEVELOPMENT AND EVALUATION

Egg and Larva Production of Northern Anchovy in 1989

The egg and larva samples collected during the 8901 cruise (January 19-February 4) have been sorted, staged, aged, and analyzed to provide estimates of daily egg production. The estimate of the 1989 daily egg production is one of the major inputs to the spawning biomass of northern anchovy.

The survey area includes CalCOFI lines 77.0 (Pt Buchon, CA) to 93.0 (Del Mar, CA). Forty-three CalVET tows were taken out to station 70.0, and 57 Bongo tows were taken up to station 120.0 (Figure 4). Egg samples from CalVET tows and larvae from Bongo tows were used to estimate egg and larva production and mortality (Lo 1986, Fish. Bull., U.S. 84(2)).

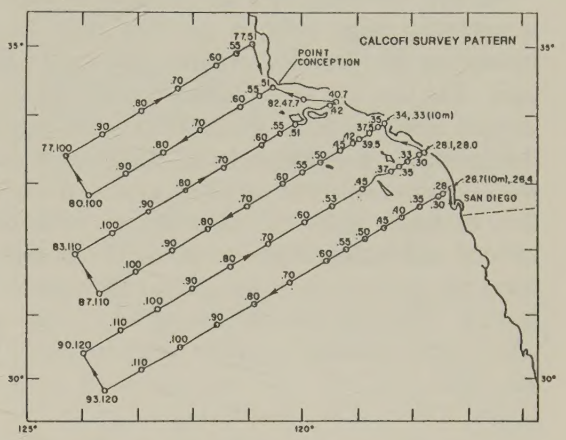


Figure 4. CalCOFI survey pattern.

The preliminary estimates of daily egg production and daily egg instantaneous mortality rate are 2.01/0.05 m^2 (SE=0.61) and 0.58 (SE=0.062). The larva production at hatching is 0.142/0.05 m^2 (0.014). Both egg and larva production were lower than previous years (Table 1). The average temperature of tows where eggs were present was 13.17°C compared to 13.30°C in 1988. With such a low temperature, we expect that only 5% of one-year-olds will be mature, and the estimated spawning biomass will be below the 1 million metric ton estimate of 1988.

Table 1. Anchovy daily egg production per 0.05 m^2 (P_0), daily egg mortality, larva production at hatching per 0.05 m^2, and average temperature in January-February 1985-1988. Standard error in parenthesis.

Year	1985	1986	1987	1988	1989
Egg Production	5.16 (2.16)	7.55 (3.34)	7.23 (2.57)	6.89 (3.42)	2.01 (0.61)
Egg Mortality	0.28 (0.05)	0.34 (0.12)	0.19 (0.08)	0.53 (0.09)	0.58 (0.06)
Larva Production	2.30 (0.38)	4.61 (0.26)	4.85 (0.90)	0.57 (0.13)	0.14 (0.01)
Temperature (°C)	14.11	14.77	14.69	13.30	13.17

(N. Lo, FTS 893-7123)

SURVEY SYSTEMS DEVELOPMENT AND EVALUATION

Quantitative Deep Oblique Tows Implemented

Fishery Biologist Paul Smith reports that the quantitative deep oblique tow has been implemented by Bill Flerx, Fishery Biologist, for the third year. The tow is intended to encompass the entire vertical range of sablefish and Dover sole eggs for the purpose of estimating egg production rates. Mature Dover sole and sablefish inhabit the ocean floor at depths of 200 to 1000 fathoms (400-1800 meters) and all sablefish and some Dover sole inhabit the surface layer as part of their early life history. This requires the use of an oblique tow which encompasses the entire water column. The standard CalCOFI tow encompassed only the upper 70 meters for the first years of sampling. It was deepened to 140 meters from 1951 to 1966 and further deepened to 210 meters from 1969 to the present.

The quantification of oblique tows is accomplished by one value, the standard haul factor (SHF) and the verification of one assumption. The assumption is that approximately equal volumes are filtered from each depth of interest. This assumption allows one to refer eggs per unit volume of water to eggs per unit area of sea surface.

The SHF allows each observation to be standardized to a unit referred to as eggs per 10 space meter of sea surface area. The equation for the standardized haul factor is (Kramer and Ahlstrom 1968, CalCOFI Atlas 9):

$$SHF = \frac{10*D}{R*A*P}$$

where "D" is the depth in meters, "R" is the number of revolutions of a flow meter in the mouth of the net, "A" is the area of the mouth of the net, and "P" is the length of the column of water in meters needed to effect one revolution of the flow meter. The units for the reciprocal of the SHF are the mean number of cubic meters of water filtered per 10 meters of depth.

For shallow tows (<200 m) the depth of tow and trajectory of the net are estimated from the mean of the tangents of the wire angle. For deep tows, the wire angles do not provide accurate estimates of depth, so for this purpose we have included a conductivity temperature and depth device (CTD). From this instrument we display measures of depth and record depth and temperatures each 20 seconds (Figure 5). The display allows us to control the ship and winch speeds to follow an approximately straight trajectory (Figure 5). The distributions of the standard haul factor are shown in Figure 6. The lower haul factor for the deep bongo reflects the greater volume of water filtered per unit depth, not the greater depth.

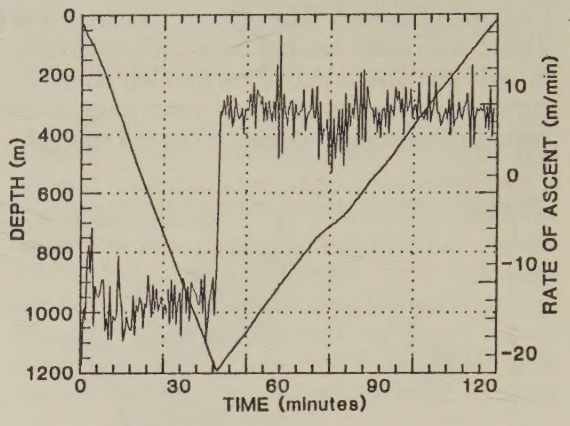


Figure 5. The trajectory of a deep bongo tow to 1200 meters depth (scale at left). The rates of ascent and descent (scale at right) are plotted each 20 seconds. On descent, the desired rate is 15 meters per minute. On ascent the desired rate is 7 meters per minute.

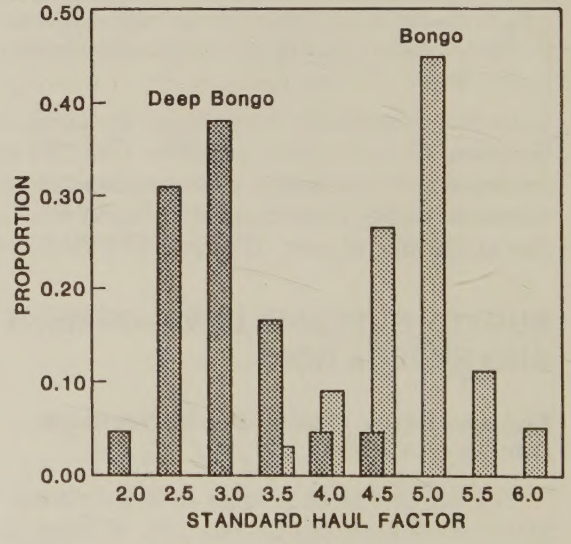


Figure 6. Relationship between the standard haul factor for the deep bongo (left) and the standard bongo (right).

The main reason the deep bongo has a smaller standard haul factor is that the net is towed faster. The faster tow makes precise con-

trol of the ship speed possible. The equation that relates the tangent of the wire angle to the ship speed is:

$$V = V_o + \exp(r*\tan a)$$

where V is estimated ship speed in meters per second, V_o is the estimated intercept from a nonlinear least squares fit to the expected equation by the Marquardt algorithm, "r" is the exponential slope parameter and "tan a" is the tangent of the wire angle in degrees. The parameters and standard errors for the equation are V_o=0.692 (0.039) and r=0.271 (0.037). The scatter plot is shown in Figure 7. The curve explains about 54% of the variance of the data.

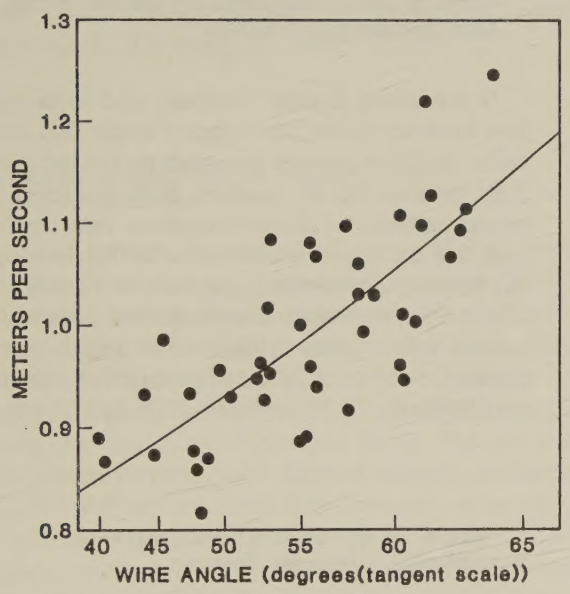


Figure 7. A scatter plot and fitted exponential curve for the empirical relationship between the speed of tow and the tangent of the wire angle at the surface.

In practice, it is not possible to tow the net in an even trajectory. It takes several minutes before the net responds to the change in ship's speed with the long towing wire. Also, there are undersea currents at different times and places which alter the configuration of the towing wire. Thus, our prime requirement is that each 10 meter level has equivalent variation in volume filtered over the survey area even though there will be cases of undersampling and oversampling on individual tows. The success of this procedure depends on the actual distribution of the organisms in question. In the extreme case, if the eggs are randomly distributed, the assumption of even trajectories is unnecessary. If the non-randomness is exhibited as broad depth zones (50 meters +) containing the various stages of eggs, presumably the number of alternating episodes of over- and under- sampling would be sufficient to result in little or negligible bias. If the layer proves to be so compact that significant bias or imprecision arises from trajectory error, which we cannot control, the procedure will have to be refined. (P. Smith, FTS 893-7169)

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

Recent Trends in Worldwide Tuna Production and Trade Analyzed

Sam Herrick, Industry Economist at the La Jolla Laboratory, and Tony Applebaum, Student Intern from San Diego State University, have completed an analysis of recent trends in global catches of tuna and canned tuna production. They find that worldwide catches of tuna have increased steadily from 2.462 million metric tons (mt) in 1979, to 3.418 million mt in 1986, an increase of 39% in 8 years. From 1979 to 1985, global production of canned tuna rose from 607,000 mt to 703,000 mt, an increase of 16%. While these increases in catches and canned tuna production are impressive in themselves, perhaps more striking is the considerable development in the harvesting and canning capabilities of less developed countries relative to that of the historically dominant tuna harvesters and canners, namely Japan, the United States, Spain and France. The rapid development of tuna industries in southeast Asia (Thailand, Indonesia, Philippines, Korea, Taiwan, Malaysia, India, China), Latin America (Mexico, Venezuela, Panama, Brazil), the island nations of the western Pacific, and Africa (Ghana, Ivory Coast) has been largely due to their proximity to abundant tuna resources, relatively low-cost labor sources, strong government backing, and investments from abroad. However, while these are necessary conditions, the impetus for developing tuna industries in these areas relates to a growing worldwide demand for tuna and processed tuna products.

The linear trend model in Figure 8 shows global tuna catches increasing at an annual average rate of 5% between 1979 and 1986, with most of this increase due to growth in the fishing operations of developing nations. Growth in the catches of developing nations

increased at an annual rate of 6% over the period, from 1.2 million mt in 1979 to 1.9 million mt in 1986. This compares to average annual growth rate of 3%, with much more variability, for developed nations, with their catches ranging from 1.3 million mt in 1979 to 1.5 million mt in 1986. By 1986, developing nations accounted for more than half of the world's annual tuna catch. The trend model predicts that by 1995 the global tuna catch will reach 4.5 million mt (plus/minus 300,000 mt). The global catch trend, projection and 95% confidence bands are shown in Figure 8. Separate linear forecasts for the developing nations' catch and the developed nations' catch are 2.7 million mt (plus/minus 200,000 mt) and 1.8 million mt (plus/minus 400,000 mt) respectively by 1995.

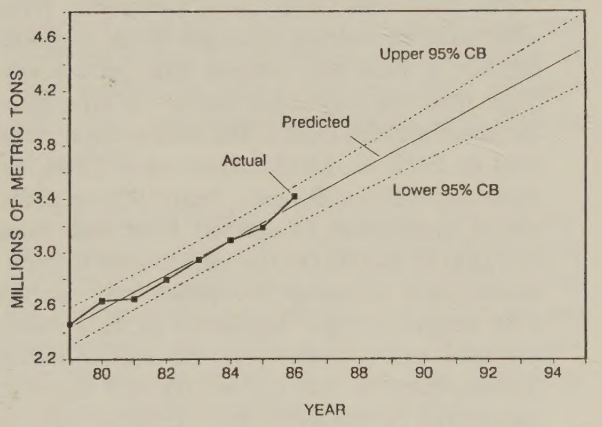


Figure 8. Actual and predicted global tuna catches, 1979-1995.

Globally, canned tuna production grew at an average rate of 3% annually from 1979 through 1985 as shown in Figure 9. The rapid development of canned tuna processing capability in developing nations over the period accounts for most of this growth. From 1979 to 1985 canned production by developing nations increased 84%, at an average annual rate of 11% compared to a 5% increase for developed nations, at an average annual rate of 1%. By 1985, developing nations accounted for 22% of the world's annual canned tuna production vis a vis 14% in 1979. The linear trend model for canned tuna predicts global production will reach 900,000 mt (plus/minus 200,000 mt) by 1995. The developing nations' production is estimated to be 270,000 million mt (plus/minus 60,000 mt), and production by developed nations is predicted to be 630,000 mt (plus/minus 150,000 mt) by 1995, based on linear trends estimated for each.

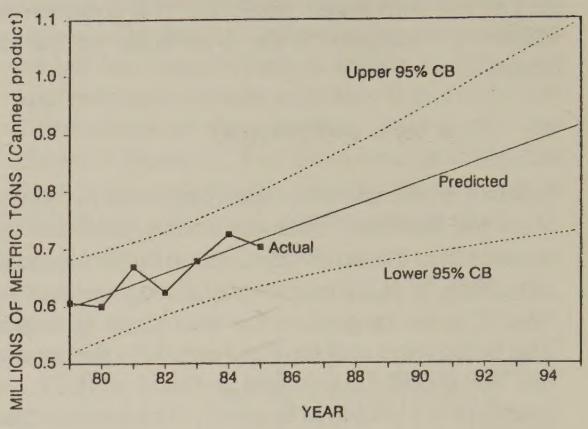


Figure 9. Actual and predicted global canned tuna production, 1979-1995.

If prevailing trends continue, and assuming that tuna resources can support expanded harvests, global output of raw and processed tuna may increase by as much as 30% by 1995. If recent patterns of growth continue into the future, this expansion is likely to be led by developing nations with burgeoning tuna industries, in which case, the tuna industries of the developed nations will continue to face more intense competition, both on the fishing grounds and in the marketplace. (S. Herrick, Jr., FTS 893-7111).

Progress of Southern California Sportfish Economic Survey

Industry Economist Cynthia Thomson has been working with a private contractor, HBRS of Madison, Wisconsin, to complete development of survey instruments for the southern California sportfish economic survey. The survey is sponsored jointly by the National Marine Fisheries Service and the California Department of Fish and Game, and is designed to: 1) estimate the number of marine recreational anglers residing in southern California; 2) estimate the number of fishing trips for finfish and shellfish during the year and the distribution of these trips by key variables such as area and target species; 3) predict the effect of catch rates and angler characteristics (such as income, boat ownership, education and ethnicity) on the demand for fishing; and 4) estimate the economic value of the recreational fishery and how this value is affected by changes in catch rates.

The sampling design involves: 1) a random telephone canvass of the general population in southern California coastal counties to determine the prevalence of finfishing and shellfishing activity; and 2) a follow-up mail questionnaire directed at those telephone respondents who made at least one saltwater fishing trip in the previous 12 months. The survey covers both shore- and boat-based trips in southern California, including boat trips departing from U.S. waters but fishing in Mexican waters. Anglers who do not reside in southern California coastal counties (and are therefore not included in the telephone canvass) will also be represented in the survey. Names and telephone numbers of such individuals will be obtained from the intercept portion of the Marine Recreational Fishery Statistics Survey. (C. Thomson, FTS 893- 7116)

Economic Models of Pacific Coast Commercial Fisheries

Dale Squires, Industry Economist, SWFC, and Wesley Silverthorne, Regional Economist, SWR, continued developing a mixed integer programming model of the west coast sablefish fleet. The model will be used to address the allocation of sablefish quota between the fixed gear (fish pot and long line) and groundfish trawl fleets. Squires has also been working with Samuel Herrick, Industry Economist, in the initial development stages of a coast-wide quadratic programming model. This model will incorporate the major gear types and fisheries and will be used to analyze policy questions as they arise. (D. Squires, FTS 893-7113)

New Chairman for PFMC's Scientific and Statistical Committee (SSC)

At the Pacific Fishery Management Council meeting, March 1989, Dr. Daniel Huppert, Industry Economist at the La Jolla Laboratory, was installed as Chairman of the Scientific and Statistical Committee. Dr. Huppert has been a member of the committee since 1980, and takes over the chairmanship from Dr. Donald Bevan of the University of Washington. Duties of the Chairman include developing meeting agendas, running the five or so meetings per year, and reporting SSC comments and recommendations to the Council. (D. Huppert, FTS 893-7114)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION

La Jolla, California

BIOLOGY ASSESSMENT PROGRAM

Report Completed on Mineralization Patterns in Teeth of Pilot Whales

Investigation of age determination in pilot whales has been undertaken by Christina Lockyer, visiting research scientist from the Sea Mammal Research Unit, Cambridge, England, during her sabbatical year here at the Southwest Fisheries Center. The study is needed in order to verify age for catches of long-finned pilot whales (*Globicephala melas*) taken in the subsistence-type fishery around the Faroe Islands in the northeast Atlantic. This year pilot whales will be discussed at the meeting of the Scientific Committee of the International Whaling Commission, in San Diego, beginning May 20. Lockyer plans to present her findings there.

The true incremental deposition rate of laminae in hard tissues has been investigated and established directly for some marine mammal species, but not pilot whales, by studying teeth from animals of known age or history, and the use of tetracycline administrations to "timemark" hard tissues (i.e. dentine and cementum in teeth and bone). Teeth of mammals have frequently been used to determine age, and the method of counting laminations in the dentine and/or cementum of the teeth is routinely employed for most species of toothed cetaceans. The main problem is how to interpret laminae in relation to real time: what constitutes a daily, lunar and annual growth layer? The laminations in the dentine and/or cementum have generally been defined in terms of differing mineralization density and/or quality: high and low, a contiguous pair of which constitute a growth layer group (GLG), as defined in the review report edited by Fishery Biologist William Perrin and Wildlife Biologist Al Myrick, Jr. (Age determination of toothed whales and sirenians. Rep. Int. Whal. Commn (Spec. Iss.) 3:1-229, 1980). Detailed examination of teeth of many mammal species reveal that events may occur which appear to create systemically rather than locally

caused disturbances in the normal regular deposition rate of laminae in the teeth. (Myrick, Jr., A. C. 1988, Is tissue resorption and replacement in permanent teeth of mammals caused by stress-induced hypocalcaemia? *In*: Z. Davidovitch (ed.), The biological mechanisms of tooth eruption and root resorption, pp. 379-89. EBSCO Media, Birmingham, AL 35233.) Myrick has described such disturbances (mineralization anomalies) in cetacean teeth, and has proposed models which may explain the effect of "stressors" in causing these anomalies in teeth.

The purpose of Lockyer's study is twofold. First, the aim has been to determine the true incremental rate of deposition of dentinal and cemental laminae in the teeth of pilot whales in order to interpret GLG's correctly for age, upon which many biological parameters are dependent for accuracy. Second, the aim has been to progress beyond this stage, and compare teeth extracted from a) the same individual to investigate conformity of GLG patterns, and b) different individuals derived from various sources and localities to study easily identifiable mineralization anomalies which might have biological significance, and assist identification of potential stressors.

One tooth was available for each of seven known-history captive northeast Pacific short-finned pilot whales, a closely related species *Globicephala macrorhynchus*. This material was made available by Sea World, San Diego. Six of the seven animals had received tetracycline medication sometime during their lives. Teeth were collected from these animals at death. Investigation indicated that in animals of age years, numbers of cemental and dentinal growth layer groups (GLG's) in the teeth were equal. From comparison of known history, tetracycline marks and other biological information, the implied incremental rate of deposition is one GLG per year. The dentinal and cemental GLG's may therefore be used directly for age determination in years.

In addition, teeth were available for each of 235 northeast Atlantic long-finned pilot whales, and duplicate teeth were examined for 10 of these. This sample comprised 91 whales captured on September 11, 1986, in the Faroese drive fishery at Sandur on the island of Sandoy, at approximately 61°30'N, 0°11'E, 36 whales stranded on August 21, 1982, at Rif in Iceland, at approximately 64°56'N, 23°50'W, and 108 whales stranded on October 26, 1986, at Thorlakshofn in Iceland, at approximately 63°51'N, 21°22'W. Comparison of duplicate teeth from the mandible of single individuals, revealed that GLG counts were similar and deposition patterns and mineralization anomalies were consistent in teeth from the same individual. This implies that all teeth are potentially good for determining age and that deposition patterns are characteristic for the individual as well as being evidence of systemic control.

Investigation of mineralization anomalies in the teeth from captive whales (for which stressors could be identified) as well as in teeth from free-living northeast Atlantic long-finned pilot whales indicated the following characteristics, previously described by Myrick (1988), for which they were scored in terms of occurrence by sex, current age, reproductive maturity, age at which the anomaly appeared, and in which calendar year. These are 1) mineralization interference: irregularities in the lamina formation emanating from differential inhibition/activation of odontoblasts at the mineralization front (normally, the pulp cavity edge), causing realignment of the dentinal tubules and resulting in wavey lines, swirls and asymmetry, which disrupt usual patterns yet do not prevent continuous lamina formation; 2) dentinal resorption: actual erosion and frequent repair of existing regular laminated dentinal tissue, resulting in an amorphous and/or globular appearance, frequently with holes, cutting across and into regular tissue; 3) cemental disturbance: any anomalous appearance of the usual regular laminated cemental tissue, including mineralization interference and resorption; 4) pulp stones: discrete nodules containing concentric rings in the dentine; 5) marker lines: both in dentine and often cementum: discrete laminae which are regular yet noticeably different in appearance from the boundary layers in morphology and affinity for stain.

Results of the scoring show that mineralization interference increases with age reaching 60-100% incidence in animals over 14 years in both Icelandic and Faroese animals. The incidence is related to age rather than state of maturity. Cemental disturbance has a low incidence in Icelandic whales, and reaches ca 50% incidence in Faroese whales. This is also age-and maturity-related. Dentinal resorption has not been recorded in any immature animals of either sex. Incidence reaches a peak in old males, yet does not appear to greatly affect females until age 25 years. The dentinal resorption occurs very frequently in the Faroese animals, reaching almost 100% incidence in males. The incidence in

Icelandic animals is <10% until age 25+ years when incidence rises from 20% to 40% in very old animals (30+ years). The difference in these levels of incidence by location and sex could indicate varying degrees of susceptibility, perhaps genetically controlled, or could simply be a measure of local stress factors produced by the environment or generated by behavioral traits within the school. Could such circumstances, revealed in the teeth, result in differential mortality and sex ratios? Pulp stones, when present, tend to be associated with age at which puberty usually occurs, and the incidence does not greatly increase thereafter. Marker lines occur throughout life at all ages, after age one year, regardless of state of maturity, and therefore, as anticipated, incidence increases with age; calendar year is also a significant factor for Icelandic samples. In particular, the year 1960 is very prominent for Iceland (both in Thorlakshofn and Rif), when >40% teeth from whales which would have been alive at that time exhibited a marker line. This year does not feature in the Faroese sample. What may have caused this is not known, but a future investigation of the environment at that time may be worthwhile. Of particular interest is the question that if factor(s) affecting two independent groups of Icelandic whales did not influence the Faroese group, could these whales have originated in separate regions and probably not mixed?

Observations from the known-history captives indicate that likely stressors causing (directly or indirectly) mineralization anomalies may include sexual maturation, pregnancy and/or parturition, periods of starvation, as well as changes in health and life style. Environmental as well as inherent physiological rhythms are likely to be key factors worth investigating in the future.

This study was facilitated by the co-operation of the Sea World Research Institute and Hubbs Marine Research Center, San Diego, for provision of material and access to data on captive pilot whales. The provision of material and data on pilot whales by the Marine Research Institute, Reykjavik, Iceland, and also the Natural History Museum, Torshavn, Faroe Islands, are gratefully acknowledged. In particular, J. S. Leatherwood, J. Sigurjonsson and D. Bloch are thanked for their help. This study was funded by the U.S. Department of Commerce, Grant Award No: NA-88-ABH- 00040, while a resident at the Southwest Fisheries Center, La Jolla, California, where facilities were made available. Help from Priscilla Akin, Aleta Hohn and Al Myrick is greatly appreciated. (C. Lockyer, FTS 893-7090)

FISHERY DEPENDENT ASSESSMENT PROGRAM

Effects of Dolphin Group, Percent Coverage, and Fleet Size on Estimates of Dolphin Mortality Derived From Tuna Vessel Observer Data.

Records of dolphins killed incidental to purse-seining for tuna by U.S. registered vessels fishing in the eastern tropical Pacific Ocean during 1987, were analyzed to assess the effects of three factors on estimates of dolphin mortality incurred by an entire fleet, when only a portion of the fleet is actually observed. Data from 1987 were used because this is the first year that nearly 100% of trips carried observers. The three factors were 1) dolphin group, 2) percent coverage (percent of fishing trips observed by scientific technicians), and 3) fleet size. Estimates were derived using the ratio estimator (kill/day) for eight dolphin groups (total dolphins, northern offshore spotted dolphins, eastern spinner dolphins, whitebelly spinner dolphins, unidentified spinner dolphins, common dolphins, striped dolphins, and other dolphins), for simulated fleet sizes of 33, 20, 10 and 5 boats, and simulated sampling levels of 25%, 33%, 50%, 75%, and 96% observer coverage.

Four statistical aspects of these mortality estimates were investigated to assess the effects of the three factors named above, on the estimates: 1) relative bias of the estimate, 2) coefficient of variation of the estimate, 3) frequency distributions of replicate estimates, and 4) 95% confidence intervals of replicate estimates.

Mortality estimates and their statistical (sampling) characteristics were affected in decreasing order of influence by dolphin group type, percent coverage, and fleet size (Figures 1 and 2). The strongest control on estimates was the characteristics of the data contributing to the estimates; for groups with relatively frequent and relatively similar kill/trip (e.g., total dolphins), a given level of accuracy and precision could be achieved with relatively low percent coverage even with relatively small fleets. Intermediate levels were adequate for groups with intermediate data characteristics (e.g., whitebelly spinner dolphins, with relatively infrequent but relatively homogeneous kills), but for dolphin groups with relatively rare and heterogeneous

kill/trip (e.g., common dolphins), much higher levels of coverage are required to achieve the same level of accuracy and the level increases with smaller fleets.

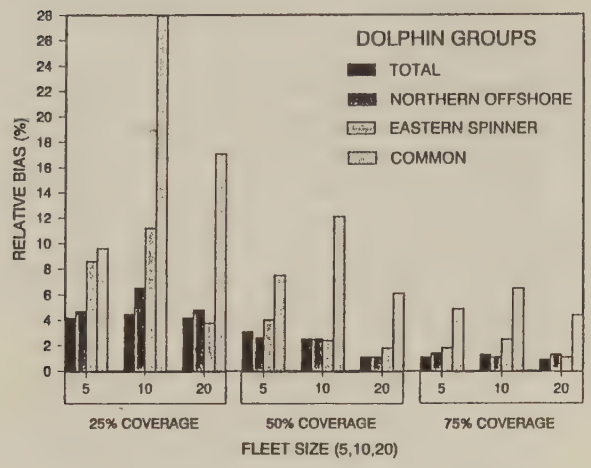


Figure 1. Relative bias in estimates of annual dolphin mortality. The first three sets of columns show results for 25% coverage, the next three sets show results for 50% coverage, and the last three sets show results for 75% coverage.

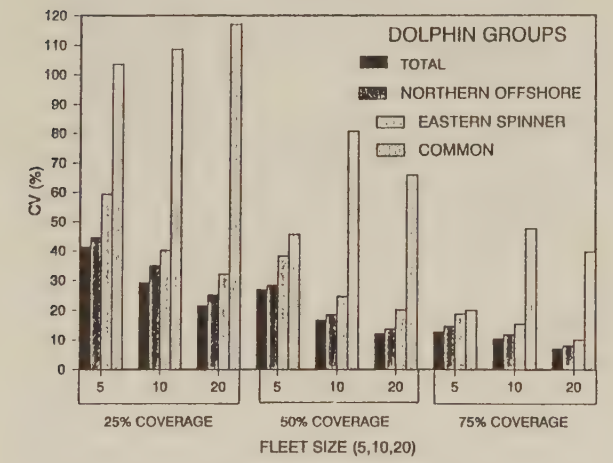


Figure 2. Coefficients of variation for estimates of annual mortality. The first three sets of columns show results for 25% coverage, the next three sets show results for 50% coverage, and the last three sets show results for 75% coverage.

As specific examples, coefficient of variations (CVs) 20% or less could be achieved for estimates of total annual mortality given 25% coverage of a fleet of 20 boats, or 50% coverage of a fleet as small as 5 boats. CVs of 20% or less for whitebelly spinner dolphins required coverages of at least 75% for a fleet of 5 boats, and at least 50% for fleets of 20 boats. CVs of 20% or less could not be achieved for estimates of common dolphin annual mortality with coverages less than 100%, at any fleet size.

Because neither fleet size nor dolphin group type can be controlled by a sampling program, the only alternative available to achieve given levels of accuracy and precision in estimates of dolphin mortality is to manipulate the level of observer coverage. To protect equally all groups, it would be necessary to use the level required for those dolphin groups characterized by the "messiest" data. (E. Edwards, FTS 893-7099)

Environmental Variability in the Eastern Tropical Pacific, 1986-1988

Oceanographer Paul Fiedler reports that large interannual changes in the eastern tropical Pacific (ETP) are evident in environmental data collected on MOPS dolphin stock assessment cruises since 1986 (August-November, NOAA Ships *McArthur* and *David Starr Jordan*). A smoothed time series of the Southern Oscillation Index (Figure 3) shows that a moderate El Niño occurred in 1987. In 1988, this El Niño was followed by a cold-water event ("La Niña"). As an illustration of the extreme environmental variability observed during the first 3 years of MOPS, the range of SOI during 1986-1988 exceeds the range before, during, and after the great 1982-1983 El Niño.

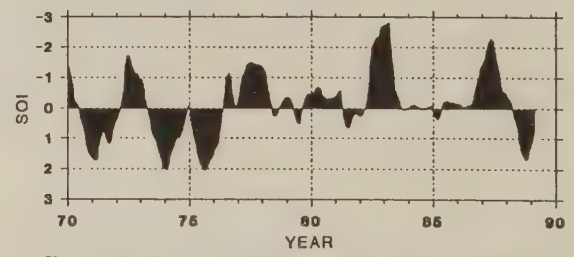


Figure 3. Smoothed time series of the Southern Oscillation Index (SOI). Data from Climate Diagnostics Bulletin (NOAA/NWC/Climate Analysis Center).

Anomalously warm surface temperatures were observed in the central Pacific, at the western edge of our study area, by summer 1986 (Climate Diagnostics Bulletin, NOAA/NWS/Climate Analysis Center). Our XBT data were supplemented by some data from other NOAA ships and ships of opportunity. They were analyzed by Dave Behringer at NOAA/ERL/Atlantic Oceanographic and Meteorological Laboratory to produce fields of

surface temperature and depth of the 20°C isotherm (thermocline depth).

During August-November 1986, we observed surface temperature anomalies of 0 to +2°C in the ETP, with the warmest anomalies in the equatorial cold tongue west of 105°W. The equatorial thermocline ridge was anomalously deep and displaced to the south. In 1987, surface temperature anomalies were at least +1°C throughout most of our study area and +2 to +3°C in the equatorial cold tongue. The depth and position of the equatorial ridge were closer to normal, but the thermocline ridge at 10°N, between the North Equatorial Countercurrent and the North Equatorial Current, was weaker than in 1986. These anomalies indicate changes in currents and water mass distribution associated with El Niño. In 1988, the equatorial cold tongue was as much as 3°C colder than normal, but surface temperatures north of the equator were generally within 1°C of normal. The equatorial ridge had shoaled, indicating a strengthened South Equatorial Current.

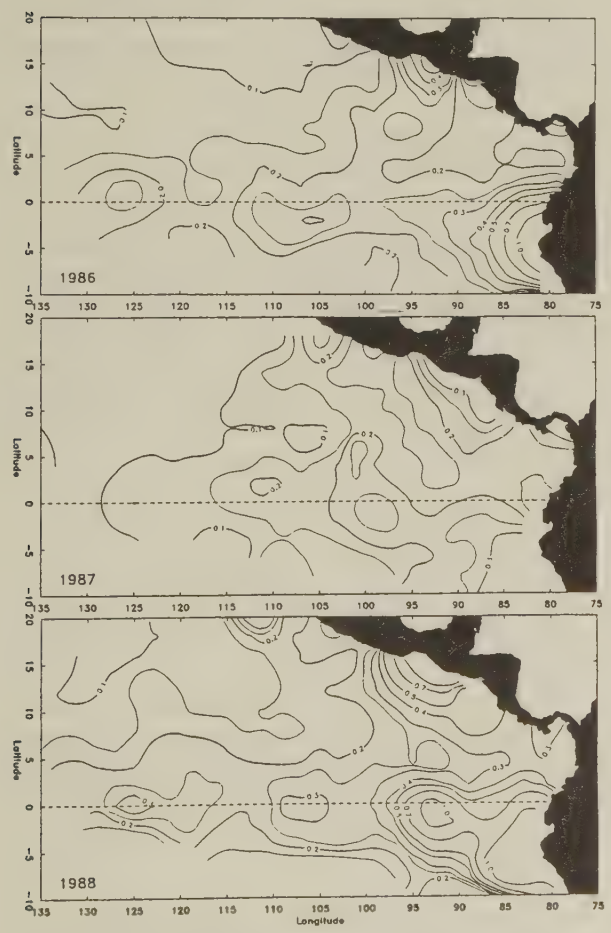


Figure 4. Surface chlorophyll values (mg m^{-3}) observed during MOPS cruises in August-November

Surface chlorophyll data show a major biological response to the 1986-1988 environmental variability (Figure 4). Although no climatology exists for chlorophyll, the 1986 values appear "normal" compared to 1967 EASTROPAC results. Equatorial upwelling sustained high surface chlorophyll concentrations between 5°N and 5°S, increasing towards the coast of Ecuador and Peru. Chlorophyll values were low north of the 10°N thermocline ridge and to the west towards the oligotrophic subtropical gyre. In 1987, surface chlorophyll concentrations were significantly lower than in 1986, especially along the equator where the temperature data indicated reduced upwelling of cold, nutrient-rich water. In 1988, surface chlorophyll concentrations were more than twice as high as in 1987 and also significantly higher than in 1986. Equatorial upwelling in 1988 was driven by anomalously strong trade winds (Climate Diagnostics Bulletin).

We will integrate these chlorophyll data with our temperature, nutrient and subsurface chlorophyll data in a presentation at the first annual conference of The Oceanography Society in August and in a paper to be submitted to Science. Many people have helped collect these data since this project was initiated by Fishery Biologist Steve Reilly, who is also directing bird censuses and biological collections on the MOPS cruises. We acknowledge Vicky Thayer (formerly SWFC), Julie Ellingson (PMC), Gregg Thomas (AOML), Oceanographer Lisa Lierheimer and Computer Specialist Robert Holland. The results of these efforts will be an unprecedented time series of environmental data in the eastern tropical Pacific and will be invaluable in the interpretation of variability in dolphin abundance and distribution. (P. Fiedler, FTS 893-7016)

HONOLULU LABORATORY

Honolulu, Hawaii

Scientists Participate in International Marine Debris Conference

A number of fishery scientists from the Honolulu Laboratory participated in the Second International Conference on Marine Debris, which was held in Honolulu, Hawaii, April 2-7, 1989. Conference participants from all over the

world presented more than 100 papers on a wide range of topics: sources of marine debris; entanglement and ghost fishing; ingestion of marine debris; economic impacts; and solutions through technology, law, public policy, and education. The conference was chaired by Richard S. Shomura, formerly director of the Honolulu Laboratory and a key figure in organizing the first International Conference on Marine Debris in 1984.

Fishery Biologist Tim Gerrodette of the Honolulu Laboratory presented the paper "An experimental study of derelict gill-net fragments in the central Pacific Ocean," which was coauthored by Fishery Technicians Barry K. Choy and Lisa M. Hiruki. The paper gives the results from a 1986-87 study on the behavior and fate of four fragments of a high-seas squid gill net (50-1,000 m long), which were observed closely for 3 days and subsequently tracked by satellite for up to 10 months. The net fragments changed length, shape, heading, and location under the influence of wind and current. The time a net remained open in a fishing configuration varied from hours to weeks, depending on its initial length. The nets drifted at an average speed of 15 km/day, but with frequent changes in direction, they remained in the general vicinity of the Hawaiian Archipelago. The complex movement of the net fragments means that predicting the drift of marine debris is an oceanographic problem requiring detailed knowledge of surface currents and wind.

George H. Balazs, Leader of the Marine Turtle Research Task, presented the paper "Ecological aspects of marine turtles impacted by ocean debris, a 1989 perspective." Available evidence indicates that ingestion of man-made debris floating on the high seas has the greatest potential for adversely impacting sea turtle populations. A major problem in gathering detailed information on this phenomenon is the inability of researchers to locate pelagic habitats used by juvenile turtles of all species. Pelagic habitats used as foraging sites by sea turtles are believed to be frontal systems (convergences, rips, drift lines) where buoyant food and debris are drawn together by advection. International concern for the impact of buoyant wastes in the ocean is heightened by the fact that many sea turtle populations are endangered and have experienced serious declines from overfishing and other adverse factors.

Fishery Biologist John R. Henderson's paper "Recent entanglements of Hawaiian monk seals in marine debris," documented 34 observed incidents of entanglement on *Monachus schauinslandi* in 1985-88, including 4 known deaths, injuries to 2 seals, and 2 seals that had recent neck scars from injuries. The overall entanglement rate increased tenfold, from a low of 0.26 incidents/100 camp days in 1985 to a high of 2.66 incidents/100 camp days in 1988. This rise is probably attributable to higher amounts of marine debris on and around the islands where seals haul out. Sixty-nine entanglements have been documented since 1974.

For the conference, Fishery Biologist Raymond P. Clarke of the Honolulu Laboratory and Jo-Anne N. Kushima of the State of Hawaii's Division of Aquatic Resources, prepared the poster "Marine debris and epipelagic fishes." Their poster documented two instances of marine debris apparently impacting two epipelagic fishes: 1) a mahimahi, *Coryphaena hippurus* (total length, 77.5 cm; weight, 2.06 kg including net fragment), with a monofilament nylon net fragment attached to its gills and opercular area, and 2) a swordfish, *Xiphias gladius* (total length, 140 cm; weight, 10 kg), with a rubber band cutting (ca. 3 cm deep) into the musculature forward of its caudal peduncle. (G. Boehlert (808) 943-1221)

Biological Specimens Readied for Transfer to Major Museums

The specimen and sample storage area of the Honolulu Laboratory underwent a major cleaning and reorganization, April 17-28, to create additional space for current and future biological samples. A committee, headed by Fishery Biologist John Henderson and composed of Fishery Biologists Paul M. Shiota, Ray F. Sumida and James H. Uchiyama, produced a plan in January for the reorganization.

Many of the staff reorganized storage areas and discarded samples of little value to the scientific community, including deteriorated, unlabeled, or easily replaced specimens. Specimens of fish and invertebrates, no longer of use to Honolulu Laboratory scientists but from Pacific areas not often sampled, were designated for transfer to major museums. A list of these samples was then sent to various institutions, with a request to indicate whether they wished to include any of the samples in their collections.

Collections from the current reorganization were allocated to several institutions, with the guidance of Dr. Bruce B. Collette, Director of the

NMFS Systematics Laboratory. Specimens had been obtained in previous years by the U.S. National Museum of Natural History, Washington, D.C., and the Bernice P. Bishop Museum, Honolulu, both identified by the NMFS Systematics Laboratory as the most important repositories for the Honolulu Laboratory's collections. A number of other museums expressed interest but could not actively aid in the transfer of specimens. Robert J. Lavenberg of the Los Angeles County Museum of Natural History (LACM) visited the Honolulu Laboratory on April 4-5 to identify specimens of interest to LACM and arrange for two curatorial assistants to pack them during May 3-10 for shipment to LACM.

The LACM will catalogue and curate the samples and, for the specimens not needed in Los Angeles, arrange for their transfer to the American Museum of Natural History, California Academy of Sciences, and Museum of Comparative Zoology at Harvard (MCZ). The Honolulu Laboratory's specimens at the LACM will be available for inspection or loan to any qualified scientists needing them for research. Also, Scripps Institution of Oceanography has requested that zooplankton samples collected in the 1950's through the 1970's be held for future transfer.

Unused collections of larval and juvenile fishes are also being donated to LACM, for division between that museum and MCZ. Both institutions have received National Science Foundation grants in recent years to build major larval fish research collections. These grants are a result of the interest in ontogenetic characters useful in fish systematics generated by the Ahlstrom memorial symposium held at the NMFS SWFC La Jolla Laboratory in 1983.

The transfer of the Honolulu Laboratory's collections to LACM will make them available to the entire scientific community. The aid provided for the transfer by LACM in funding, supplies, and personnel will make this possible. (B. Mundy (808) 943-1212)

FISHERIES OCEANOGRAPHY RESEARCH PROGRAM

Boehlert Presents Seamount Paper in Azores

Laboratory Director George W. Boehlert presented the paper "Biological processes on seamounts and their role in fisheries productivity" at the 9th Week of Fisheries of the Azores, a conference held in Horta, Faial, Azores, March 6-10, 1989. His paper drew considerable interest because of the large number of seamounts in the Azorean region and the similarities between Hawaii's and the Azores' fisheries (e.g., tuna, insular fishes).

This meeting brings together various fisheries expertise from around the world to address problems concerning the Azorean fisheries. About 200 foreign and local participants presented scientific papers as well as economic, marketing, and other industry-related papers, such as one on vessel financing. Discussions at the meeting focused on the Azorean fisheries' problems and needs (e.g., research, data, economics, markets). Azorean fishermen who attended the meeting seemed quite interested in the issues discussed.

The Azorean fisheries, particularly for tuna, are expanding, although most European Economic Community (EEC) countries are in the process of reducing fishing power and tonnage under guidance of the European Commission, whose representatives attended the meeting. In the next decade, the exclusive economic zones (EEZ's) of all EEC countries will be "opened up" to the community. It is perceived that the fisheries of the Azores and Madeira are not fully utilized; therefore, expansion of the fleets is being allowed in these two areas before the EEZ is opened. Between now and 1991, the Azores can increase tonnage by 20% and fishing power by 37%. Also planned is the expansion of the tuna catch--mainly skipjack tuna, *Katsuwonus pelamis*, and bigeye tuna, *Thunnus obesus*--from 18,000 metric tons (t) to 30,000 t. (G. Boehlert (808) 943-1221)

PELAGIC RESOURCES INVESTIGATION

Research on "Burnt Tuna" Progressing

Research on "burnt tuna" is being conducted by Cheryl Watson, a graduate student in the Department of Physiology, John A. Burns School of Medicine, University of Hawaii, utilizing the Honolulu Laboratory's Kewalo Research Facility. "Burnt tuna" is a product quality problem affecting large yellowfin tuna, *Thunnus albacares*, and bigeye tuna, *T. obesus*, intended to be sold for "sashimi" (i.e., for raw consumption).

Although perfectly edible when cooked, burnt tuna is considered unsuitable for the sashimi market and therefore commands only a small fraction of the price of top quality fish.

An exact measure of the cost of burnt tuna to the Hawaiian tuna fishing industry is not available, but the total, annual, direct ex-vessel losses are estimated at $3.0 million. (This figure does not take into account retail losses or potential export markets that remain undeveloped.) The ex-vessel value of yellowfin and bigeye tuna landings in Hawaii was $12 to $20 million in 1987, so the importance of the burnt tuna problem can be easily appreciated. Reliable, cost-effective techniques to prevent or minimize this problem are clearly needed.

Watson's research is centered on the new hypothesis that burnt tuna is not directly caused by acidity and high muscle temperature that occur during capture, but rather is a result of digestion of specific muscle proteins by calcium-activated proteases (i.e., enzymes that cause protein destruction), which become activated postmortem. This theory was originally delineated by Peter W. Hochachka and Richard W. Brill ("Autocatalytic pathways to cell death: a new analysis of the tuna burn problem," Fish. Physiol. Biochem. 4:81-87, 1987).

Watson has expanded this basic hypothesis to include the theory that adrenaline and noradrenaline, which are hormones that fish produce in response to stress, accelerate the activity of calcium-activated proteases ("A comprehensive theory on the etiology of burnt tuna," Fish. Bull. 86:367-372, 1988). The expanded theory explains why the "burnt tuna syndrome" occurs more often in fish caught by handline and rod and reel, and in female fish caught during the summer. It also explains why other measures to reduce the incidence of burnt tuna, such as chilling and brain destruction are relatively ineffective.

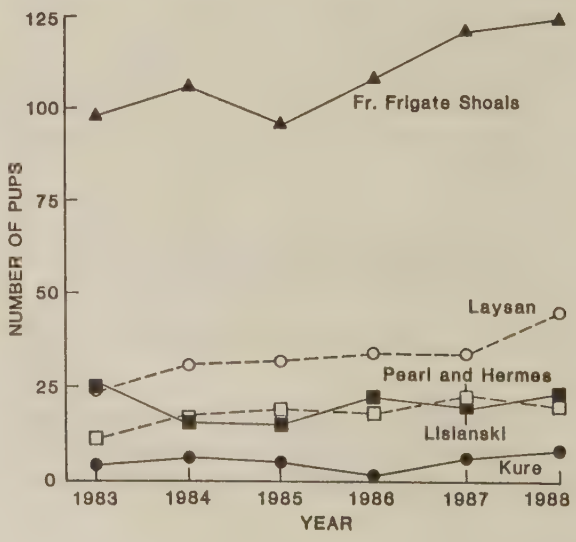
Using an electron microscope, Watson has found that samples taken from burnt tuna showed characteristic deterioration in muscle structures known to be specifically attacked by calcium-activated proteases (the Z-disk was selectively removed from the sarcomeres of burnt tuna), confirming the original hypothesis. More recently, biochemical analysis of burnt tuna, conducted by using SDS-PAGE electrophoresis, indicates that a specific protein appears to be attacked by the calcium-activated proteases. The specific identity of this "marker protein" is yet unknown, but immunological testing (Western blot technique) is being used to determine its identity. More important, since this protein is a reliable indicator of burnt tuna, it may eventually be possible to develop a test that obviates the current practice of quartering tuna suspected of being burnt. This need to cut open the fish to check for burnt tuna devalues the fish even if it is not burnt.

Heretofore the burnt tuna syndrome has been recognizable only in wholesale fish markets. Work is now under way to reproduce the syndromes in the laboratory, by using small, isolated muscle samples. Work done in this manner to date indicates the proposed theory is correct and that the muscle deterioration in burnt tuna is due to a calcium-based proteolysis. Surprisingly, the biochemical causes of burnt tuna also appear to be the same as those causing damage to the human heart muscle during heart attack and those causing some forms of muscular dystrophy. Work on burnt tuna may therefore have implications to medical science as well as to fishery science. (R. Brill (808) 943-1234)

MARINE MAMMALS AND ENDANGERED SPECIES PROGRAM

Hawaiian Monk Seal Births Are Increasing

Since 1983, personnel of the National Marine Fisheries Service have tagged the weaned pups of Hawaiian monk seals, *Monachus schauinslandi*, at all breeding locations in the Northwestern Hawaiian Islands, to monitor pup production and survival (Figure 1). The pup production



count includes all tagged pups, known deaths, and pups still nursing at the end of the field season. More than half of all births occur at French Frigate Shoals. Total births have increased over the past 2 years. Total known production was 161-184 pups in 1983-86, 204 pups in 1987, and 223 pups in 1988. The recent overall increase reflects increases in the numbers of pups born at French Frigate Shoals, Laysan Island, and Kure Atoll. The numbers of pups born at Lisianski Island and Pearl and Hermes Reef show no clear pattern and are less complete because of the low field effort at these two locations. (T. Johanos-Kam (808) 943-1221)

Green Turtle Habitats in Kaneohe Bay Documented for Long-Term Monitoring and Assessment

Two discrete habitat sites in Kaneohe Bay, Oahu, were recently identified as being intensively used by the green turtle, *Chelonia mydas*, according to George H. Balazs, Leader of the Marine Turtle Research Task. One site (ca. 0.25 km^2 3-7 m deep) is used as a benthic resting area for adult and immature turtles, and its bottom substrate is mainly outcroppings of *Porites* coral. The other site is a shallow (m deep), narrow, sandy bottom zone (100 m wide by 1 km long) where turtles forage on a luxuriant meadow of sea grass, *Halophila hawaiiana*.

During three daytime study visits to these sites, 15 turtles were hand-captured by researchers using scuba or snorkel gear. All turtles were measured and tagged, and the status of their health was assessed prior to release. No previously tagged turtles were encountered, although existing records show that adults originally tagged at the breeding site of French Frigate Shoals 750 km to the northwest have been resighted in Kaneohe Bay.

Two problems were identified during the course of this preliminary investigation. Fibropapillomas were found on 8 (57%) of the 15 turtles captured, constituting the highest rate seen thus far anywhere in Hawaii. The sizes of these epithelial growths ranged from 0.5 to 8 cm in diameter or length. Two of the turtles had multiple, extensive growths, which likely were interfering with normal behavior. Studies at other sites in Hawaii have shown that fibropapillomas on green turtles can grow rapidly and reach gross proportions in only 2-3 years. The second problem identified was the displacement of turtles from segments of the *Halophila* foraging pasture. This is due to tour operators and other vessels anchoring within the zone on a daily basis for recreational activities with large groups of people.

More information will be generated on both of these problems with the implementation of a long-term research and monitoring program. In the immediate future, cooperative work will take place with a veterinary pathologist from the University of Florida; the pathologist will visit Hawaii to biopsy fibropapillomas in search of the elusive etiological agent. (G. Balazs (808) 943-1221)

FISHERY MANAGEMENT RESEARCH PROGRAM

Preliminary Estimates of Hawaii's Fisheries Landings and Value in 1988

Preliminary estimates of Hawaii's commercial fishery were prepared by Samuel G. Pooley, Industry Economist, for inclusion in the NMFS publication, Fisheries of the United States, 1988. The estimates, using the publication's rather unusual reporting requirements, are as follows:

Species group	Pounds (1,000's)	$US (1,000's)
Marlin	2,757	2,853
Bottom fish	1,675	2,647
Tunas	12,705	23,754
Shellfish	1,531	5,508
Other fish	2,463	4,987
Total	21,131	39,749

These figures, which show a 30% increase over 1987, should be used only as early indications of Hawaii's fishery status in 1988. Revised figures will be included in the annual report modules prepared for the fishery management plans for the Western Pacific Regional Fishery Management Council (Council).

Preliminary Status Report on the Bottom Fish Fishery in the Northwestern Hawaiian Islands

A brief status report on Hawaii's bottom fish fishery was prepared for the Council's April meeting in American Samoa. The report, which is based on preliminary data from NMFS market sampling, shows that bottom fish landings in Hawaii have remained about the same for the past 3 years. However, landings from the Northwestern Hawaiian Islands (NWHI) have fallen by 34% since 1986, while landings from

the main Hawaiian islands have increased by 89%. Only 13 vessels were active in the NWHI bottom fish fishery in 1988. Activity at year's end was quite low.

Statistician Shares Data on Foreign Longline Fishery in Pacific

Peter Williams, Assistant Fisheries Statistician of the Tuna and Billfish Assessment Programme of the South Pacific Commission (SPC), visited the Honolulu Laboratory in March 1989 to share data on the foreign longline tuna fishery in the Pacific. Williams prepared a dBASE III menu program to integrate NMFS and SPC tuna longline logbook data while preserving confidentiality of the NMFS data. The program searches for corresponding vessels, checks overlapping data by date of set, and writes the location at the 10° square level of accuracy.

Small Boat Fishery Economics for American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands

Laurel Kasaoka, Cooperative Researcher with the Council, completed compilation of small boat economic data from surveys conducted last year in American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands. Data on basic vessel operating patterns, economic costs, and revenues are summarized in her report "Summary of Small Boat Economic Surveys from American Samoa, Guam, and the Northern Mariana Islands" (Administrative Report H-89-4C) and will be integrated into a descriptive report with joint authors from each of the three areas.

Precious Coral Fishery Revives

The Fishery Management Research Program received its first log under the Precious Coral Fishery Management Plan (FMP). The log reports the harvest and number of fishing days for one trip taken under the existing quotas of the FMP. This trip represented the second taken by a domestic vessel in the western Pacific precious coral "fishery," but the previous trip was taken to an area of the fishery conservation zone that, prior to the recent FMP amendment, required neither a permit nor logs. Because only one vessel has participated in the fishery, no data summaries can be released. Recently, two vessels requested experimental permits to fish in areas and in quantities otherwise precluded by the FMP. Both applications are pending action by the Director of the Southwest Region. (S. Pooley (808) 943-1216)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

FISHERY/ENVIRONMENTAL LINKAGES

Chapters Prepared for Peruvian Upwelling Volume

Application of the comparative method of science is one promising approach toward developing improved insight into the interactions of fish population dynamics and natural environmental variability. For a number of years PFEG scientists have been developing a framework of comparative climatology of neritic habitats from which to draw generalized inferences as to stock - recruitment issues, identification of trends in fishery productivity, interspecies interactions, effects of habitat alterations or climatic change, etc. This has involved certain international collaborations.

For the past several years, one aspect of PFEG activity in this direction has been participation in a multilateral study of the population dynamics and ecosystem characteristics of the Peruvian anchoveta. The co-sponsors of the study are the Instituto del Mar del Peru (IMARPE); the Federal Republic of Germany's Deutsche Gesellschaft fr Technische Zusammenarbeit (GTZ), and the International Center for Living Aquatic Resources Management (ICLARM). PFEG scientists prepared three chapters for an initial volume, "The Peruvian Anchoveta and Its Upwelling Ecosystem: Three Decades of Change," which was published by ICLARM in 1987.

Within the past few months, PFEG scientists have prepared four new chapters to be included in a second volume, to be entitled "The Peruvian Upwelling Ecosystem: Dynamics and Interactions." These have been transmitted to ICLARM and are now in press. The titles, authors names, and abstracts are listed below.

Andrew Bakun. Mechanisms for Density-Dependent Growth of Anchoveta: Alternatives to Impact on the Regional-Scale Food Supply.

Two alternate classes of mechanisms that could account for evidence of density-dependent growth are introduced: 1) effects of potential linkages of school size with population size, and 2) effects of size-dependent predation. These may lead to different interpretations with respect to resilience to exploitation, carrying capacity of the habitat, etc., from those implied by the more commonly cited class of mechanisms which involve impact of the population on its food supply.

Andrew Bakun and Roy Mendelssohn. Alongshore Wind Stress 1953-84: Correction, Reconciliation, and Update through 1986.

Corrected values are presented for the monthly series of alongshore stress presented in the previous volume of this series. The series is updated through 1986. The faulty "old" and corrected "new" series are compared and found to have very similar properties. It is concluded that studies that may have been based on the "old" series will not be significantly in error.

Roy Mendelssohn. A Reanalysis of Estimates of Recruitment of the Peruvian Anchoveta in Relationship to the Other Population Parameters and to the Surrounding Environment.

The new recruitment estimates of the Peruvian anchoveta are analyzed with respect to other population parameters and the surrounding ocean environment. The inshore and offshore environmental variables are shown to differ in their dynamics, and the inshore series vary north to south. For the inshore locations, it is not possible to resolve whether a wind related effect is due to transport or turbulence. The new recruitment estimates differ significantly from the old estimates, partly due to mackerel consumption acting as a surrogate for SST. Models using the monthly data were not possible due to correlations in the populations that could be spurious. On a yearly basis, a nonlinear additive model using parent biomass and transport at Trujillo explained 75% of the variance in the recruitment estimates.

Richard H. Parrish. The South Pacific Oceanic Horse Mackerel (*Trachurus picturatus murphyi*) Fishery.

The horse mackerel fishery of the South Pacific currently dominates the world's catch of horse mackerels. The rapid increases in catches of horse mackerel by South American purse seine fleets and the distant water USSR trawl fleet are discussed and the geographical expansion of the trawl fishery is shown utilizing ship surface weather observations.

Due to disagreement on the taxonomic identity of the species which supports the fishery a review of the world's *Trachurus* was made. The results of this review show that neither of the eastern Pacific forms of *Trachurus* merits full species rank. It is concluded that both are subspecies of the oceanic horse mackerel (*Trachurus picturatus*); *T. p. symmetricus* in the northeastern Pacific and *T. p. murphyi* in the southeastern Pacific. It is further suggested that it is likely that the range of *T. p. murphyi* extends clear across the southern hemisphere west wind drift region (i.e. from the south Atlantic to Chile). (A. Bakun (408) 646-3311)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

FISHERY MONITORING AND EVALUATION PROGRAM

Statistics Reviewed on the U.S. Canned Tuna Industry for 1988

Statistics describing the U.S. canned tuna industry for 1988 were recently compiled by Wes Parks, SWFC; Pat Donley, SWR; and Sam Herrick, SWFC, and presented as a feature article in the May issue of the Region/Center Tuna Newsletter. Data shows that the number of active U.S. purse seiners declined to 74 in 1988, continuing the trend begun in 1984 (Figure 1).

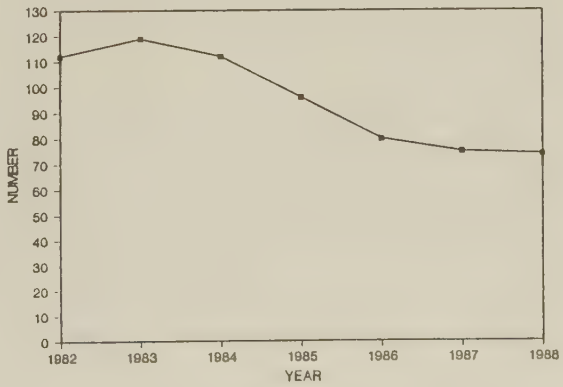


Figure 1. Number of active (at least one trip during the year) U.S. purse seiners, 1982-1988.

In 1988, 57% of the vessels operated in the eastern Pacific and 43% operated in the western Pacific.

Total receipts of raw tuna by U.S. canneries declined slightly in 1988, but were still well above the recent low of 450,000 short tons of 1985 (Figure 2). Total receipts were 510,471 short tons with imports contributing slightly more than domestic deliveries. Skipjack tuna was the principal species in both domestically-caught and imported receipts. Major foreign suppliers were Taiwan, South Korea, and Ghana. The western Pacific was the major source of albacore and skipjack tuna whereas the eastern Pacific contributed the greatest quantity of yellowfin tuna.

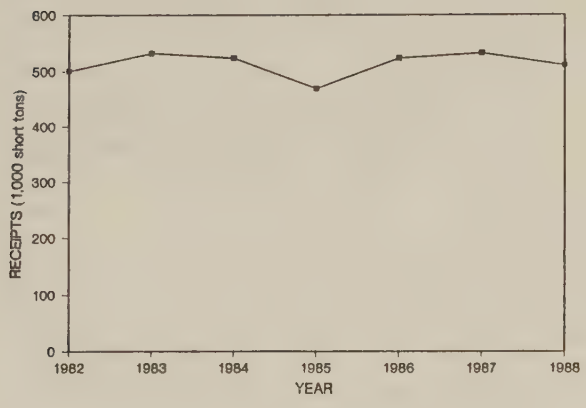


Figure 2. U.S. cannery receipts of raw tuna, 1982-1988.

Contract prices for domestically-caught raw tuna delivered to U.S. canneries in American Samoa and Puerto Rico in early 1988 were slightly higher than in late 1987, then declined later in the year to levels below those of 1987. Weighted average exvessel prices paid by canners for domestically-caught tuna increased for the third straight year to $1,094 per ton for yellowfin tuna, and to $977 per ton for skipjack tuna, and were at their highest level since 1982.

U.S. production of canned tuna declined slightly in 1988 reversing the recent increasing trend (Figure 3). U.S. canners packed 31 million standard cases of tuna valued at over $960 million. U.S. imports of canned tuna reached a record high continuing the increasing trend of recent years. Total imports were 12.5 million standard cases of tuna, valued at over $298 million. Wholesale list prices in California for canned tuna in early 1988 was at late 1987 levels, but rose slightly by year's end.

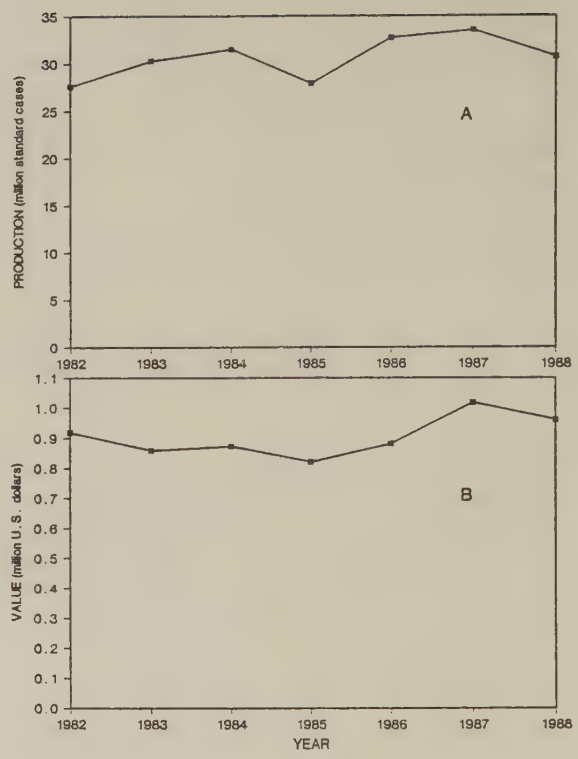


Figure 3. U.S. production of canned tuna: A. Volume, B. Value.

(W. Parks, FTS 893-7074)

STOCK ASSESSMENT AND IMPACT ANALYSIS PROGRAM

Pacific International Billfish Angler Survey

The Pacific International Billfish Angler Survey, which started in 1969, annually collects information on billfish angler catch rates in the Pacific and Indian Oceans. This is the 19th year of the Survey. Results of the previous year's Survey, determined from the responses from billfish anglers, are updated in each issue of the Billfish Newsletter.

Results - 1987 Survey

In 1987, the total number of billfish fishing days (or angler days) reported by those anglers responding to the Survey was 14,847. Of this number, 13,722 angler days were reported for the Pacific Ocean (and Indo-Pacific), and 708 angler days reported for the Indian Ocean. The remaining angler days, 417, were reported by

anglers fishing in the Gulf of Mexico, Caribbean Sea or Atlantic Ocean.

Anglers responding to the Survey reported catching 6,625 billfish in the Pacific Ocean and 364 billfish in the Indian Ocean, for a total of 6,989 billfish. Species breakdown for the Pacific Ocean catch was 997 blue marlin, 368 black marlin, 3,460 striped marlin, and 1,800 sailfish. For the Indian Ocean, it was 17 blue marlin, 8 black marlin, 26 striped marlin, and 313 sailfish. The catch rate for the Pacific Ocean was 0.48 fish per day or 2.1 days per fish. For the Indian Ocean, the rate was 0.51 fish per day or 1.94 days per fish. These catch rates are lower than those reported in 1986, 0.51 for the Pacific, and 0.66 for the Indian Ocean.

The Pacific Ocean angler catch rate for 1987 is 13% below that determined for the 1969-1972 period (0.55 fish per day).

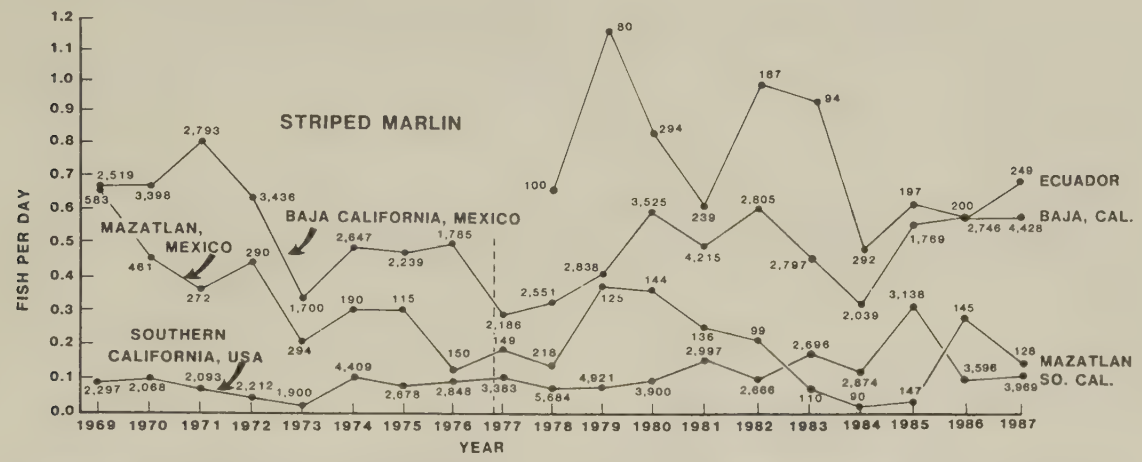


Figure 4. CPUE (number of fish/angler day) for striped marlin and number of angler days reported fishing in important catch areas, 1969-1987.

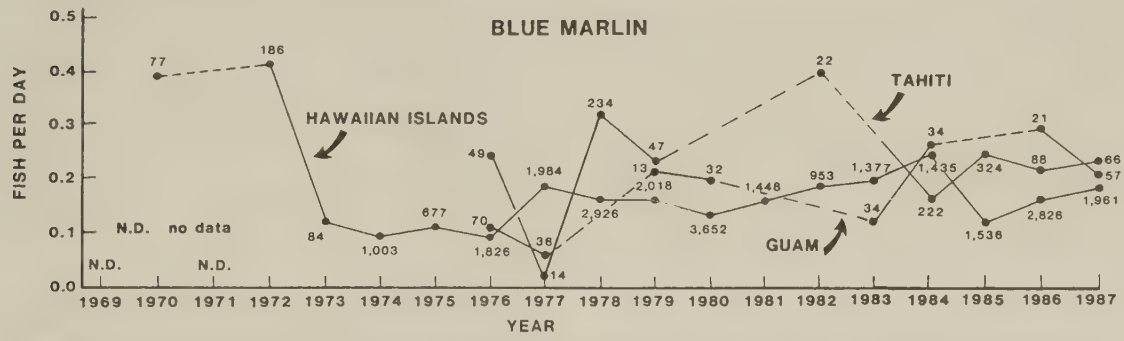


Figure 5. CPUE (number of fish/angler day) for blue marlin and number of angler days reported fishing in important catch areas, 1969-1987.

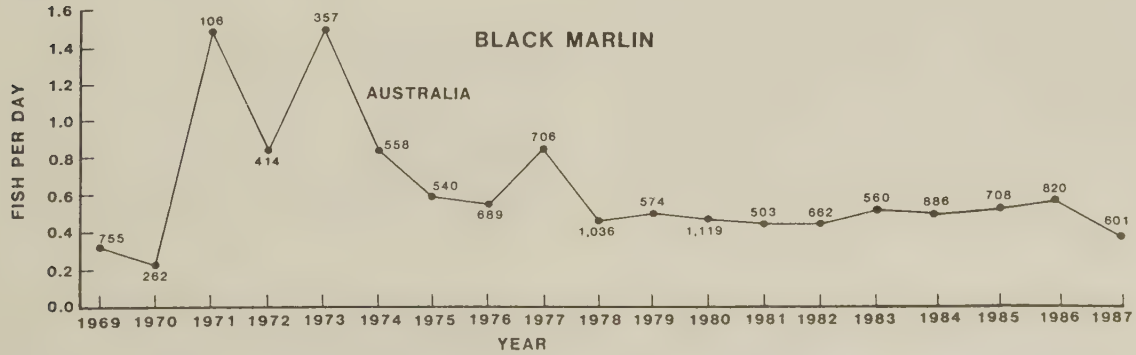


Figure 6. CPUE (number of fish/angler day) for black marlin and number of angler days reported for fishing in important catch areas, 1969-1987.

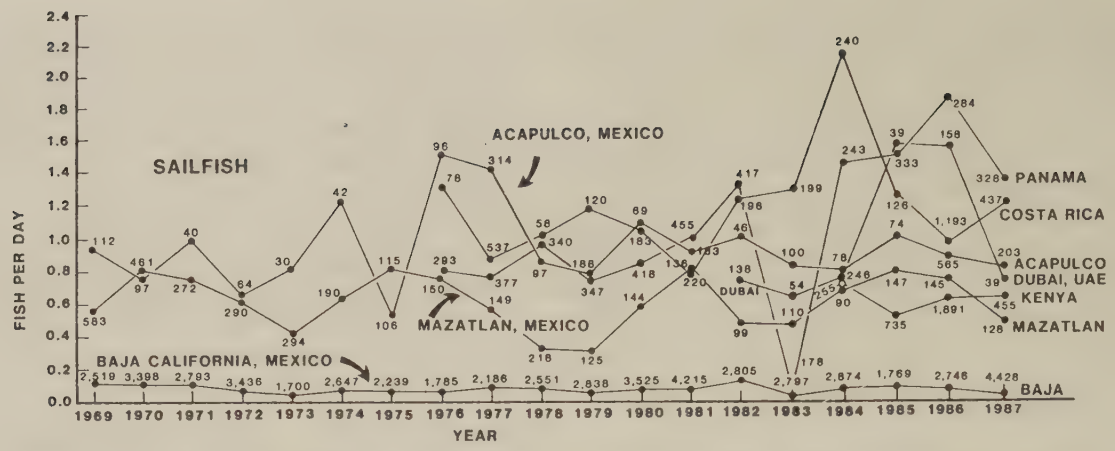


Figure 7. CPUE (number of fish/angler day) for sailfish and number of angler days reported for fishing in important catch areas, 1969-1987.

Graphics showing CPUE (catch per angler day) data are given for some fishing areas, for striped marlin (Figure 4), blue marlin (Figure 5), black marlin (Figure 6), and sailfish (Figure 7).

Table 1. Results of 1987 Billfish Angler Survey - More than 100 angler days reported.

	Angler Fishing Days	No. of Billfish	Billfish/ Fishing Day	Fishing Days/ Billfish	Major Species[1]
Pacific Ocean					
Baja California, Mexico (tip area)	4,428 (2,746)	3,236 (2,022)	0.73 (0.74)	1.3 (1.3)	SM (SM)
Southern California, U.S.A.	3,969 (3,596)	499 (401)	0.12 (0.11)	7.9 (8.9)	SM (SM)
Hawaii, U.S.A.	1,961 (2,826)	492 (836)	0.25 (0.30)	3.9 (3.2)	BLM (BLM)
Australia	601 (820)	314 (615)	0.52 (0.75)	1.9 (1.3)	BKLM (BKLM)
New Zealand	560 (532)	34 (35)	0.06 (0.07)	15.2 (15.2)	SM (SM)
Costa Rica	437 (1,193)	577 (1,268)	1.32 (1.06)	0.7 (0.9)	SF (SF)
Panama	328 (284)	597 (588)	1.82 (2.07)	0.5 (0.4)	SF (SF)
Ecuador	249 (200)	225 (160)	0.90 (0.80)	1.1 (1.2)	SM (SM)
Acapulco, Mexico	203 (565)	189 (506)	0.93 (0.90)	1.1 (1.1)	SF (SF)
Mazatlan, Mexico	128 (145)	110 (137)	0.86 (0.94	1.2 (1.1)	SF (SF)
Guaymas/Kino, Mexico	119 (124)	14 (11)	0.11 (0.09)	8.5 (11.2)	SF (SF)
Guatemala	116 (21)	148 (9)	1.27 (0.43)	0.8 (2.3)	SF (SF)
Manzanillo, Mexico	107 –	58 –	0.54 –	1.8 –	SF –
Indian Ocean					
Kenya	456 (1,891)	317 (1,194)	0.69 (0.63	1.4 (1.6)	SF (SF)

[1]SM–Striped Marlin; BKLM– Black Marlin; BLM– Blue Marlin; SF– Sailfish

Tables 1 and 2 give the results of the 1987 survey submitted by anglers, by landing locations in the Pacific and Indian Oceans. The tables include location, number of angler days reported, number of billfish reported caught, CPUE in terms of fish/day and days/fish, for locations having over 100 angler days reported, major species reported for area, and number of angler days and catch for areas reporting less than 100 angler days. Information on 1986 data is given in parenthesis (-) for comparison, for areas having over 100 anger days reported. (J. Squire, FTS 893- 7072)

Table 2. Results of 1987 Billfish Angler Survey - Less than 100 angler days reported

	Angler Fishing Days	# of Billfish	Major Species[1]
Pacific Ocean			
Thailand	72	120	SF
Tahiti	66	19	BLM
Guam	57	19	BLM
Papua New Guinea	51	4	BKLM
Peru	45	16	SM
Fiji	38	3	BLM
Japan	28	6	BLM
San Blas, Mexico	25	6	SF
Malaysia	25	5	BKLM
Caroline Islands	17	2	BLM/SF
Chile	12	0	
Christmas Island	9	2	SF
Colombia	8	7	SF
Puerto Vallarta, Mexico	7	5	BKLM
Revillagigedo Island, Mexico	5	1	BKLM
Samoa	4	4	SM
Nicaragua	3	4	SF
Indian Ocean			
Mauritius	76	14	BLM
Arabian Gulf (Dubai)	39	28	SF
Maldive Islands	24	4	BKLM
Somalia	20	1	SF
South Africa	9	1	SF

[1]SM– Striped Marlin; BKLM– Black Marlin: BLM– Blue Marlin; SF– Sailfish

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

Pacific Albacore Data Bases Updated

Anthony Majors, Fishery Biologist and Christina Perrin, Computer Programmer, have finished updating the Pacific albacore data bases with data from the 1988 southern and northern fisheries. Data are routinely collected for the northern fishery by port samplers in California, Washington and Oregon. Data for the southern fishery are collected by Gordon Yamasaki, Fishery Biologist, in American Samoa and by a sampler in Tahiti. Data are also submitted directly, from both fisheries, by vessel captains.

Data for the northern fishery consists of 268 logbooks, 168 vessel characteristics, and 248 length-frequency samples totaling over 21,000 fish. Preliminary summaries of these data show that the average sizes of fish sampled have decreased from 14.9 lbs in 1987 to 12.4 lbs in 1988 and catch rates in fish-per-standard-days fishing have increased from 70 in 1987 to 117 in 1988.

Other than two experimental years of fishing in 1986 and 1987, 1988 was the first year of substantial U.S. participation in the south Pacific albacore fishery. Data for the austral fishery consist of 15 logbooks and 58 length-frequency samples of over 4,000 fish. Preliminary summaries show that the average sizes of fish sampled have decreased from 17 lbs in 1987 to 15 lbs in 1988 and catch rates, in fish-per-standard-days fishing, decreased from 316 in 1987 to 242 in 1988.

The data for both fisheries are being summarized by Majors and Perrin as a Center Administrative Report. (A. Majors, FTS 893- 7077)

Seychelles Purse Seine Fishery Data

Al Coan, Mathematical Statistician, reports that data for purse seiners fishing in the area around the Seychelles for the last quarter of 1988, have been received from the Seychelles Fishing Authority and added to Center data bases. The data bases are available on PC diskettes and are in LOTUS spreadsheets.

The 1988 fishing season was dominated by vessels from France (20 vessels) and Spain (18 vessels). Also participating in the fishery were vessels from the USSR (4), Mauritius (3), Panama (1), Japan (1) and India (1). Catches of yellowfin and skipjack tunas in 1988 reached a record high of 213,000 mt, increasing 32% over catches in 1987 (Figure 8). The percentage of skipjack and yellowfin tuna in the catch was 53% and 47% respectively and returned to levels recorded in the period 1981-1985. Yellowfin tuna catches showed the highest percent increase, 64%, over 1987 yellowfin catches, whereas skipjack catches only increased 13%.

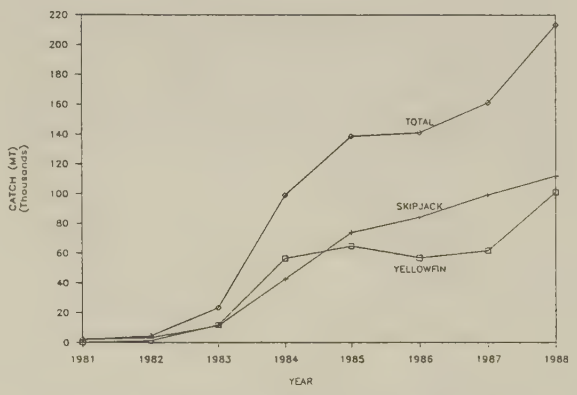


Figure 8: Purse seine catches of yellowfin and skipjack tunas in the western Indian Ocean.

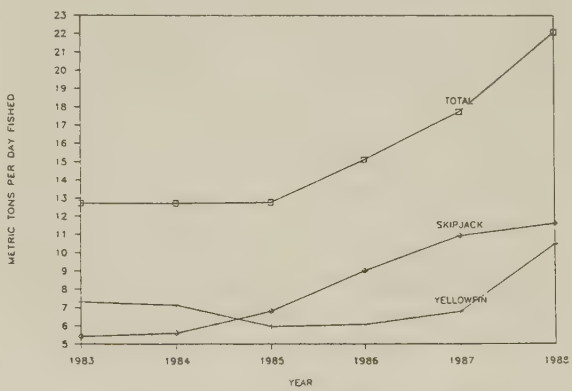


Figure 9: Purse seine catch rates in metric tons per day fished for the western Indian Ocean.

Catch rates increased from approximately 18 mt/day fished in 1987 to 22 mt/day fished in 1988 (Figure 9). Yellowfin tuna showed the greatest increase in catch rate from 7 mt/day fished in 1987 to over 10 mt/day fished in 1988. Catch rates in October of 35 mt/day fished were the highest ever recorded in the western Indian Ocean. (A. Coan, FTS 893-7079)

Tuna/Dolphin Data Bases Updated

Data collected in 1988 by NMFS technicians (observers) aboard U.S. tuna purse seiners fishing in the eastern tropical Pacific Ocean have been edited by Biological Technicians Randy

Rasmussen and Mike Trianni and placed into the tuna/dolphin database. This database contains information used to investigate the distribution, abundance, mortality and life history of the dolphin stocks involved in the eastern Pacific yellowfin tuna fishery.

In 1988, NMFS observers were on board for 31 of the 60 U.S. fishing trips and observed a total of 847 sets on dolphins. Observers counted a total of 3,373 dolphins killed in these sets for a dolphin kill per set rate of 4.00 animals and a kill per ton of tuna rate of 0.23. These rates are slightly higher than those observed in 1987 of 3.00 animals per set and 0.18 animals per ton. (A. Jackson, FTS 893-7048)

TIBURON LABORATORY

Tiburon, California

GROUNDFISH ANALYSIS INVESTIGATIONS

Covariation of Daily Growth and Birthdate Distributions of Four Juvenile Rockfish (*Sebastes*) Species

Surveys of pelagic juvenile rockfish (*Sebastes* sp.) inhabiting the coastal waters off central California have been conducted since 1983 by the Groundfish Analysis Investigation. Midwater trawls have been deployed at night along transects between Cypress Pt. and Pt. Reyes aboard the NOAA Ship *David Starr Jordan* in late spring each year. One aspect of this research has been to determine the daily age and growth of juvenile rockfish by counting the increments on their otoliths. It is thought that growth during early life history plays an important role in determining survival and year class strength. The following summarizes some results concerning the daily growth and birthdate distributions of those species completed thus far, i.e. shortbelly rockfish (*Sebastes jordani*), bocaccio (*S. paucispinis*), yellowtail rockfish (*S. flavidus*), and widow rockfish (*S. entomelas*).

For comparative purposes, linear regressions were used to describe growth, although in some cases non-linear models such as the Gompertz equation fit the data slightly better. Growth rates have been observed to covary both among species and years. For example, bocaccio grow more rapidly than shortbelly rockfish in a given year, whereas 1987 was generally a better year for growth than was 1986. To develop a standardized measure of annual growth conditions, length was estimated at a standard age for each of the four species in each year (Figure 1). The standard age selected for each species depended on the range of ages encountered among years. Note the covariation in length- at-age among the four species. It would appear that environmental conditions affecting growth in any given year are experienced similarly by all the species studied here.

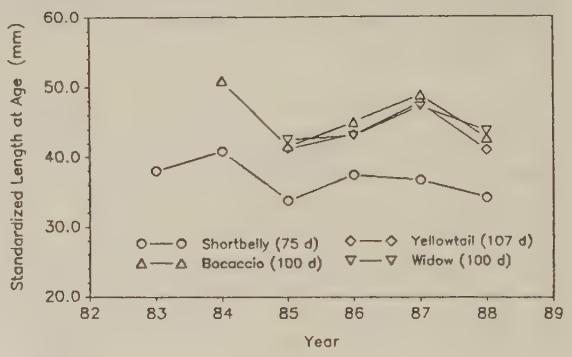


Figure 1. Standardized length at age data. Numbers in parentheses indicate age used to determine lengths.

Birthdate distributions of fish surviving from mid-winter parturition to the time of late spring sampling were estimated by: 1) regressing age on length for each species-year combination, 2) estimating individual ages from lengths of all the fish sampled (not just those aged), 3) calculating the birthdate of each fish by subtracting the estimated age from the Julian date of capture, and 4) aggregating birthdates into a composite frequency distribution. Here only mean birthdates bracketed by the maximum and minimum birthdates are presented (Figure 2). Although not shown, birthdate distributions were generally unimodal when samples were sufficiently large, except in 1987 when each species exhibited extended parturition. Like the results concerning length-at-age, the timing of parturition of survivors covaried among species and years.

This research is ongoing as additional species are processed and cruises conducted. We are currently studying the relationship between growth and dates of successful parturition with oceanographic conditions in an attempt to

determine the factors contributing to year class strength.

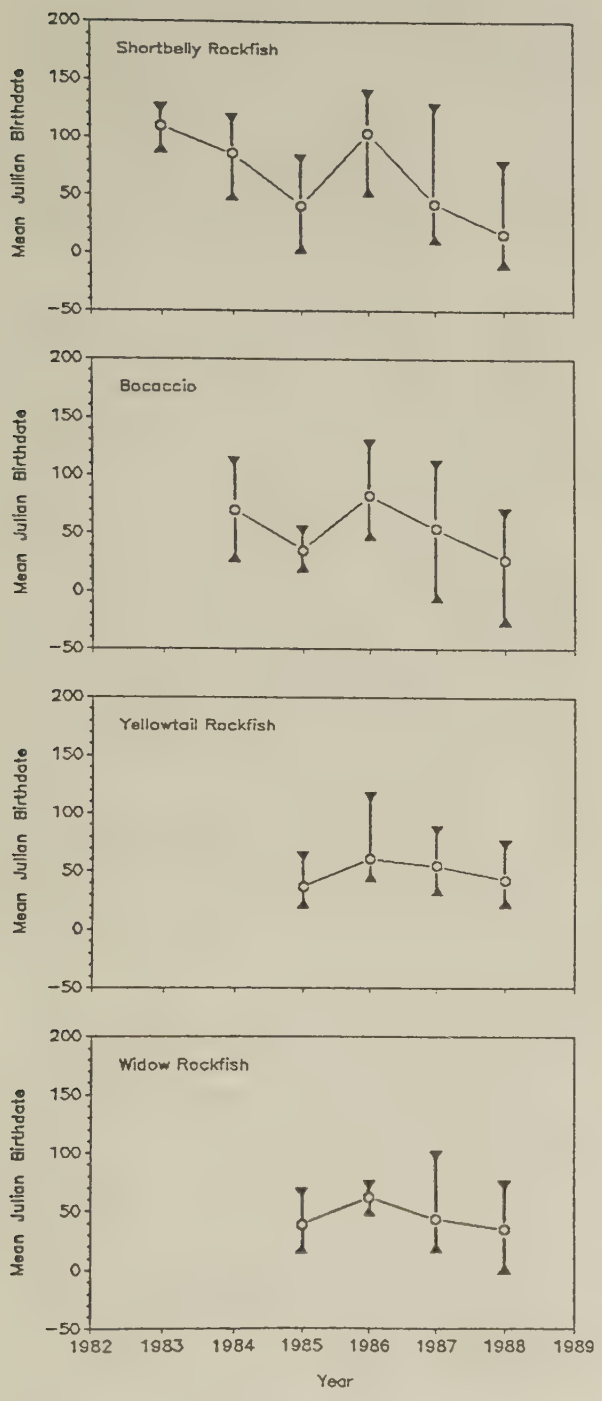


Figure 2. Mean birthdate distributions bracketed by ranges.

(D. Woodbury 556-0565)

GROUNDFISH COMMUNITIES INVESTIGATIONS

Juvenile Rockfish Found to Respond Alike to Factors Affecting Growth

Survival and mortality rates have been calculated for first-year juvenile blue rockfish, *Sebastes mystinus*, by Fishery Biologists Peter Adams and Dan Howard of the Groundfish Communities Investigation. The work is based on data from nearshore underwater census counts on the Mendocino Coast, which are part of the Tiburon Laboratory's rockfish recruitment studies.

The rates are based on counts made at three sites from August (when the numbers of recruits in the habitat stabilized) to the following April, each year from 1986 to 1989. When the numbers are plotted, regressions of the logarithm of the numbers of young-of-the-year (YOY) blue rockfish counted gives estimated daily rates of instantaneous mortality similar to those derived from catch-curve analyses. From these can be calculated monthly (30 days) instantaneous mortality rates, as well as daily and monthly survival rates (Table 1, Figure 3).

Table 1. Daily survival, monthly (30 days) survival and monthly instantaneous mortality rates for juvenile blue rockfish (*Sebastes mystinus*) for the period between the months of August to April for three locations by year.

Location	Year	Daily survival	Monthly survival	Monthly mortality
Seal Cove	85/86	0.9977	0.9354	0.067
	86/87	0.9979	0.9408	0.061
	87/88	0.9968	0.9112	0.093
	88/89	0.9941	0.8423	0.112
Whitesboro	87/88	0.9955	0.8774	0.131
	88/89	0.9915	0.7807	0.247
Horseshoe Pt.	88/89	0.9926	0.8062	0.150

That the daily and monthly survival and mortality rates vary little from year to year and from place to place (Table 1), indicates that annual and spatial influences on year-class strength are minimal during the August to April period.

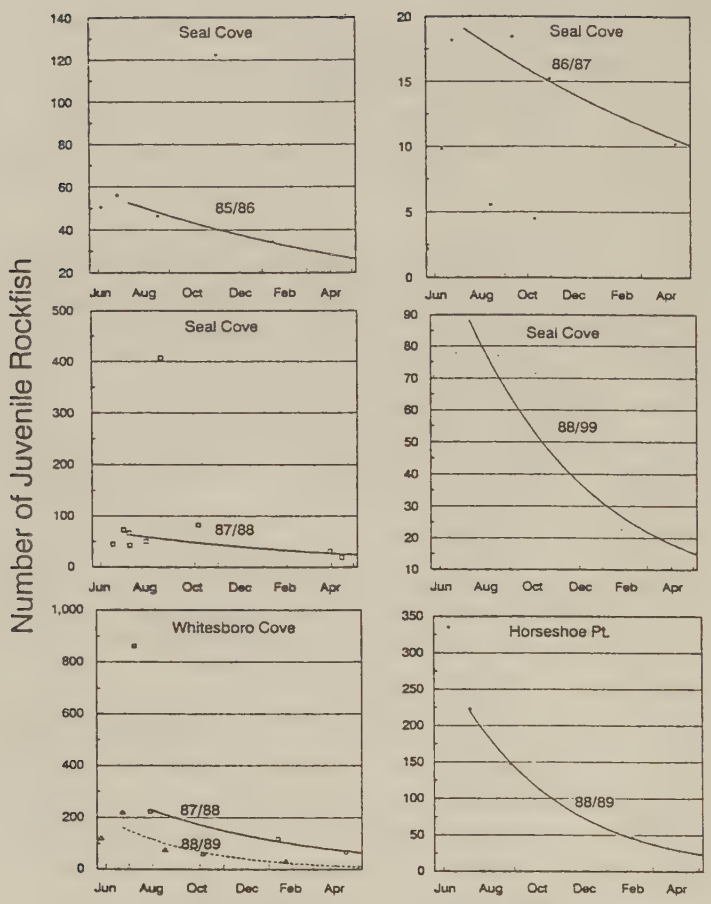


Figure 3. Mortality estimates for juvenile blue rockfish (*Sebastes mystinus*) from four locations by year.

Rates of annual (12-month) instantaneous mortality projected from these data range from 1.51 to 0.67, which can be compared to the generally accepted adult natural mortality rate of around 0.25.

Possible sources of error include net migration into the area, which would reduce the mortality estimates, and net migration out of the area, which would increase the mortality estimates. Finer-scale sampling planned for the coming year should refine these estimates. (P. Adams, FTS 556-0568)

Groundfish Physiological Ecology Investigation to Assess Condition of Juvenile Yellowtail Rockfish

Since March 1985, the Physiological Ecology Investigation has been studying the reproductive biology of yellowtail rockfish, *Sebastes flavidus*, from Cordell Bank off Bodega Bay, California. An objective of the study is to identify variables within the female that relate to reproductive success. Approximately 300 adult females have been analyzed for body condition, parasite burden, nutritional state, ovarian maturation, oocyte development, fecundity, etc. Statistical relationships between and among maternal and ovarian variables have been identified; however, the link between these variables and the viability of progeny has not been established. Ideally, evaluation of the physiological condition of recently released larvae would provide the optimum data to establish relationships with maternal factors, but locating and identifying offspring during this early life stage has not been achieved. Consequently, assessing physiological condition of juveniles (approximately 4-5 months post-parturition), a stage that can be collected and identified, has become the alternative. Despite the influences of environmental variables during the first few months at sea, it is reasonable that healthier larvae at the time of release will have a greater probability of survival and better physiological condition at the juvenile stage. Thusly, evaluating important environmental variables (e.g., temperature, food abundance) during the free-swimming larvae-to-juvenile progression and assessing juvenile condition should provide data upon which to relate maternal variables to reproductive success.

As part of the Rockfish Recruitment Assessment cruise during May and June, 1989, aboard the NOAA Ship *David Starr Jordan* in the Gulf of the Farallones and Cordell Bank, the Groundfish Physiological Ecology Investigation will collect juvenile yellowtail rockfish and assess their physiological condition. This will be the initial effort and will become a yearly activity in conjunction with monitoring female reproductive development of the Cordell Bank yellowtail rockfish population.

During this initial study, a range of measurements that potentially evaluate physiological condition will be surveyed. Subsequent data analysis should elucidate the significant relationships among the various measures of juvenile condition and between maternal values from the

condition and between maternal values from the previous adult reproductive cycle. Those juvenile variables which best describe physiological condition and relate to maternal variables will be retained for future yearly assessments. Initially, we will assess morphometrics, gross abnormalities, parasite burdens, mesenteric fat, total lipid concentration and energetic lipid to structural lipid ratios, total protein, RNA/DNA, calorimetry, stomach contents, liver histochemistry, and organ histology. Additionally, depth profiles of temperature and salinity, and plankton composition and abundance will be recorded. (B. MacFarlane, FTS 556-0569)

Condition of Bocaccio, *Sebastes paucispinus*, Assessed

Starting in 1985 bocaccio rockfish have been collected concurrently with the yellowtail rockfish as described in previous reports. The objective was to obtain a preliminary sample which might indicate the degree to which adult condition relates to effective fecundity. Because our initial emphasis was placed on yellowtail rockfish, a smaller sample was taken. Three years of collection resulted in a total sample of 140 bocaccio. After initial analyses, data showed that unlike yellowtail rockfish, bocaccio did not significantly decline in body condition with age (mean age=10.8 yrs; range=2-36 yrs; most fish were 8-11 yrs) and there were no significant correlations of parasites and disease with body condition factors measured, although as in most fish, higher nematode burdens occurred in older fish. In general, bocaccio appeared healthier than did yellowtail rockfish over the time sampled (1985-1989).

Mean fecundity of females sampled (n=18) was 1,124,227 eggs per female (range=88,133 to 2,690,900 eggs/female). Analyses of fecundity and assessments of viability in additional samples of females will be reported later. (J. Whipple, FTS 556-0569)

INFORMATION TECHNOLOGY SERVICES

Update of Information Technology 1995 (IT-95) Project

The IT-95 Project was initiated to procure a distributed processing computer system to support the complex scientific and data management needs of NOAA Fisheries into the 1990's. The procurement would provide the hardware and software for stand-alone and network processing capabilities at 7 initial sites and 2 additional sites. The 7 initial sites are Seattle, WA; Auke Bay, AL; La Jolla, CA; Honolulu, HI; Miami, FL; Woods Hole, MA; and Silver Spring, MD (Washington, D.C.). The 2 additional sites are tentatively targeted for the Pacific Fisheries Environmental Group, Monterey, CA and the Seattle Montlake Laboratory. Though targeted for these two sites, actual placement of these systems would be at the discretion of the Science Directors at the Northwest and Southwest Centers.

Upon the commitment of 3 million dollars by NMFS towards the procurement of the IT-95 system, the NOAA contracting office announced in the April 28, 1989 issue of the Commerce Business Daily that NOAA will release the Request for Proposals (RFP) to the vendors on or about May 30, 1989. The RFP identifies the mandatory requirements, options, and desired features for hardware, peripherals, and software for the IT-95 procurement. To ensure a full, open, and equal competition, the Government incorporated in this RFP the responses to the vendors who commented or questioned the mandatory requirements in the August 1988 Request for Comments, a preview of the RFP.

The RFP states that the vendor must propose a system with sufficient memory, processing capability, and I/0 capability to satisfy the requirements of the live test demonstration (LTD). The proposed system must be capable of processing the mix of concurrent interactive terminal time-sharing and batch jobs within a specified time, as directed in the benchmark package. Systems not passing the benchmark test would be considered nonresponsive.

The benchmark package is in the final phase of development by the Benchmark Team, chaired by Bob Riemann (NW). The benchmark team members from the regional sites are Frank Kikuchi (NW), Roger Hewitt (SW), Charlie Krouse (SE), Jim Sargeant (NE), and Dick Schween (HQ/RE1). The benchmark package consists of master tapes of the representative programs and data sets from each of the five sites, an instruction set, and a script for the live demonstration at the site visit. The program tapes contain a mix of COBOL, FORTRAN, and data base language programs for the Burroughs

and VAX operating systems. The vendors must convert the programs for execution on their proposed system.

With the RFP targeted for release on May 30, the benchmark package must be available to the vendors by June 10. The charge to the vendors is $300 for the package. Distribution of the package will be controlled by Meredith Beeg, the NOAA Contracting Officer. If the benchmark package cannot be completed by June 10, the release of the RFP will be delayed and held for release 10 days prior to a firm completion date of the benchmark package. Based on a May 30 RFP release date, benchmark at the vendors' sites could begin the latter part of August. (D. Roll, FTS 893-7057)

STATUS OF PUBLICATIONS

Published

Alcorn, Doris J. and Elizabeth K. Buelna. 1989. The Hawaiian monk seal on Laysan Island, 1983. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-124, 45 p.

Cole, David A. and Douglas R. McLain. 1989. Interannual variability of temperature in the upper layer of the north Pacific eastern boundary region, 1971-1987. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFC-125, 14 p.

Graham, Jeffrey B., William R. Lowell, N. Chin Lai and R. Michael Laurs. 1989. O_2 tension, swimming-velocity, and thermal effects on the metabolic rate of the Pacific albacore *Thunnus alalunga*. Exp. Biol. 48:89-94.

The oxygen consumption rates ($\dot{V}O_2$) of 9 albacore tuna, *Thunnus alalunga* (8.5-12 kg) were measured at sea in a swimming respirometer to determine the effects of relative swimming velocity, ambient O_2 tension, and water temperature. Significant positive relationships were obtained between tail-beat frequency and relative speed and between relative speed and $\dot{V}O_2$. The albacore metabolic rate was not appreciably affected by exposure to water temperatures ranging from 13.5° to 16.9°C. Brief exposure to hyperoxia (200-400 mm Hg), which was done to reduce the initial stress upon fish in the respirometer, did not affect $\dot{V}O_2$. Hypoxia (50-99 mm Hg), however, did tend to reduce $\dot{V}O_2$ and affect swimming velocity.

Humphreys, Robert L., Jr., Gary A. Winans, and Darryl T. Tagami. 1989. Synonymy and life history of the North Pacific pelagic armorhead, *Pseudopentaceros wheeleri* Hardy (Pisces: Pentacerotidae). Copeia 1989:142-153.

Specimens of the nominal species *Pseudopentaceros wheeleri* Hardy and *P. pectoralis* Hardy were examined morphologically and electrophoretically to test the validity of the two species. Samples were collected primarily from the Hancock Seamounts of the southern Emperor-northern Hawaiian Ridge as well as from the North Pacific open ocean and northwestern Hawaiian Islands. Morphometric results indicate continuity between *P. wheeleri* and *P. pectoralis*. No evidence of species separation was revealed in analyses of merisitc and electrophoretic data. We conclude that the North Pacific pelagic armorhead consists of a single, metamorphic species, which we, as first revisers, elect to call *P. wheeleri*. A hypothesis is proposed that attributes morphological variation to different life-history stages.

Owen, R. W. 1989. Microscale and finescale variations of small plankton in coastal and pelagic environments. J. Mar. Res. 47:197-240.

Somerton, David A., Bert S. Kikkawa, and Christopher D. Wilson. 1988. Hook timers to measure the capture time of individual fish. Mar. Fish. Rev. 50(2):1-5.

To measure capture time of individual fish on a longline, two types of hook timers installed in the leaders and activated by a striking fish were designed and tested: 1) A corrosion timer that measures time indirectly from the mass loss of the anode in a galvanic corrosional reaction and 2) a digital timer that measures time directly by a digital watch module. The digital timer proved to be superior because it is reusable, quicker to deploy and retrieve, and measures time directly with little error.

Approved, Science and Research Director, SWR

Bakun, Andrew. Mechanisms for density-dependent growth: alternatives to impact on the regional-scale food supply. For publication in The Peruvian Upwelling System: Dynamics and Interactions. ICLARM Studies and Reviews 18. Instituto del Mar del Peru (IMARPE), Callao, Peru.

Forsyth, Robert G., and George H. Balazs. [Green turtle, *Chelonia mydas*] Species profile: Life history and environmental requirements of the green turtle, *Chelonia mydas*, in the Pacific Ocean Region. U.S. Army Corps of Engineers, Vicksburg, MS 39180-0631.

Gerrodette, Tim, Barry K. Choy, and Lisa M. Hiruki. An experimental study of derelict gill-net frag-

ments in the central Pacific Ocean. Proceedings of the Second International Conference on Marine Debris, 2-7 April 1989, Honolulu, HI.

Huppert, Daniel D. and Roger D. Fight. Economic considerations in managing salmonid fish habitat. For publication in Salmonid habitat in forest and range lands: principles and effects of management. American Fisheries Society.

Lynn, Ronald J. and James J. Simpson. The influence of bathymetry upon the flow of the undercurrent off southern California. For consideration for publication in the Journal of Geophysical Research.

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Polovina, Jeffrey J. Artificial reefs: nothing more than benthic fish aggregators. For consideration for publication in California Cooperative Oceanic Fisheries Investigation Reports.

Simpson, James J. and Ronald J. Lynn. A mesoscale eddy dipole in the offshore California Current. For consideration for publication in the Journal of Geophysical Research.

Administrative Reports

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Clarke, Raymond P. 1989. Annual report of the 1988 western Pacific lobster fishery. SWFC Admin. Rep., Honolulu, H-89-5, 28 p.

Holland, Robert. 1989. A personal computer based system for analog-to-digital and serial communication data acquisition. SWFC Admin. Rep., La Jolla, LJ-89-09, 24 p.

Holts, David B. and Dennis Bedford. 1989. Report of the Assessment Methods Workshop for Sharks. SWFC Admin. Rep., La Jolla, LJ-89-11, 21 p.

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